Zootaxa 3543: 1–65 (2012)
www.mapress.com/zootaxa/

Monograph

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

urn:lsid:zoobank.org:pub:AD4DF500-9034-4B1F-9FB1-A0B0D441A034

ZOOTAXA

3543

A taxonomic revision of the mealybug genus *Ferrisia* Fullaway (Hemiptera: Pseudococcidae), with descriptions of eight new species and a new genus

M. B. KAYDAN[1] & P. J. GULLAN[2,3]

[1]*Imamoglu Vocational School, Çukurova Üniversity, Adana, 01330, Turkey. E-mail: bkaydan@cu.edu.tr*
[2]*Division of Evolution, Ecology and Genetics, Research School of Biology, The Australian National University, Canberra, A.C.T. 0200, Australia. E-mail: penelope.gullan@anu.edu.au*
[3]*Department of Entomology, University of California, One Shields Avenue, Davis, CA 95616-8584, U.S.A.*

Magnolia Press
Auckland, New Zealand

Accepted by C.J. Hodgson: 25 Sept. 2012; published: 7 Nov. 2012

M. B. KAYDAN & P. J. GULLAN
A taxonomic revision of the mealybug genus *Ferrisia* Fullaway (Hemiptera: Pseudococcidae), with descriptions of eight new species and a new genus
(*Zootaxa* 3543)

65 pp.; 30 cm.

7 Nov 2012

ISBN 978-1-77557-046-2 (paperback)

ISBN 978-1-77557-047-9 (Online edition)

FIRST PUBLISHED IN 2012 BY

Magnolia Press

P.O. Box 41-383

Auckland 1346

New Zealand

e-mail: zootaxa@mapress.com

http://www.mapress.com/zootaxa/

ISSN 1175-5326 (Print edition)

ISSN 1175-5334 (Online edition)

Table of Contents

Abstract

The mealybug genus *Ferrisia* Fullaway is revised to include 18 species, based on morphological and molecular data. We distinguish the widespread pest species *F. virgata* (Cockerell) from morphologically similar species and provide a revised description and illustration for the adult female of *F. virgata*. We resurrect *Dactylopius dasylirii* Cockerell **stat. rev.** from synonymy with *Dactylopius virgatus* Cockerell as *Ferrisia dasylirii* (Cockerell) and apply this name to many North American and Caribbean populations previously recognised as *F. virgata*; *F. dasylirii* is the most difficult to distinguish morphologically from *F. virgata* and exhibits morphological and molecular variation among some populations. We designate a lectotype for *D. dasylirii* Cockerell. Eight new species of *Ferrisia* are described and illustrated based on the adult female, and named as *Ferrisia colombiana* **sp. n.**, *F. cristinae* **sp. n.**, *F. ecuadorensis* **sp. n.**, *F. kondoi* **sp. n.**, *F. milleri* **sp. n.**, *F. pitcairnia* **sp. n.**, *F. uzinuri* **sp. n.** and *F. williamsi* **sp. n.** The relationships of five of these new species and five named species are discussed in relation to a previously published phylogenetic tree that was based on nucleotide sequence data. Taxonomically informative morphological features (such as the size, shape and position of discoidal pores associated with the dorsal enlarged tubular ducts and the ventral oral-collar tubular ducts), identified for each of the genetic groups (clades) on the tree, are used to help to diagnose the species. We also describe and illustrate the adult female of a form of *F. gilli* Gullan, found on *Magnolia* and some other host plants, that has numerous clusters of small ventral oral-collar ducts on the body margins. For seven named species—*F. claviseta* (Lobdell), *F. malvastra* (McDaniel), *F. meridionalis* Williams, *F. multiformis* Granara de Willink, *F. quaintancii* (Tinsley), *F. setosa* (Lobdell) and *F. terani* Williams & Granara de Willink—we provide revised illustrations of the adult females as well as diagnostic morphological notes and information on distribution and host plants. We also recognise *Eurycoccus copallinae* Ferris as a junior synonym (**syn. n.**) of *Dactylopius quaintancii* Tinsley (now *F. quaintancii*) and designate a lectotype for *E. copallinae*. We include photographs of the live appearance of the adult females of six *Ferrisia* species and also a key to all known species of *Ferrisia* based on the morphology of the adult females. We transfer the species currently known as *Ferrisia floridana* (Ferris) to a new monotypic genus, *Pseudoferrisia* **gen. n.,** as *Pseudoferrisia floridana* (Ferris) **comb. n.**, and provide a description of the genus and its type species (*Ferrisiana floridana* Ferris), as well as a new illustration of the adult female.

Key words: striped mealybug, *Pseudoferrisia*, pest

Introduction

Mealybugs (family Pseudococcidae) are small, soft-bodied scale insects (Sternorrhyncha: Hemiptera: Coccoidea) named for the white mealy or powdery wax that forms a characteristic protective covering in most species (Williams 1985a, 2004; Gullan & Martin 2009). In life, female mealybugs of the genus *Ferrisia* Fullaway are distinguished easily from other taxa of mealybugs by their long glassy filaments plus typical dorsal patterns formed by dark areas of cuticle that are bare of white wax (Figs 1 & 2). Some species, such as the striped mealybug *Ferrisia virgata* (Cockerell) and many populations of Gill's mealybug, *F. gilli* Gullan, have two dark dorsolongitudinal stripes; if the wax is removed by preservation in strong alcohol, there are usually two dorsolongitudinal lines of dark pigment. Only rarely do adult females of *Ferrisia* have a complete cover of white wax, as seen in some populations of *F. gilli* Gullan (Fig. 2C). If the bodies of *Ferrisia* females are cleared of soft contents and the cuticles stained and mounted on microscope slides, they are recognisable readily as belonging to *Ferrisia* due to the presence of dorsal enlarged tubular ducts that in life secrete the long glassy filaments. These ducts are characterised by a robust duct opening to the exterior via an irregularly circular sclerotised area bearing one or more setae and often one or more minute pores (Gullan *et al*. 2010).

Ferrisia is a New World genus and only two species, *F. malvastra* (McDaniel) and *F. virgata*, are known to have been introduced to other parts of the world, where they can be pests of cultivated plants (Williams & Watson 1988; Williams 1996, 2004). Several *Ferrisia* species are polyphagous, or at least oligophagous, and it is likely that transfers from native to exotic host plants increase their pest status. For example, *F. gilli* is believed to be native to the southeastern United States, where it feeds on a range of woody hosts, but it has been introduced accidentally to some pistachio orchards in California where its feeding damages developing nuts and the moisture from its copious honeydew leads to the growth of fungal pathogens (Gullan *et al*., 2003; Haviland *et al*. 2006). As pointed out by Gullan *et al*. (2010), *Ferrisia* mealybugs from Central and South America are intercepted often during quarantine inspections in the United States, and there is concern that these specimens are being misidentified as *F. virgata* due to undocumented cryptic species diversity (Gullan *et al*., 2003). If undescribed species are being identified as named species, then their quarantine risk will not be recognised accurately and there is an unrealised threat to agriculture and horticulture, especially in North America.

Cryptic genetic diversity in *Ferrisia* was recognised first by the late Uzi Nur (Nur, 1977; unpublished correspondence of Nur as discussed in Gullan *et al*. (2010)). Nur, while working at the University of Rochester in New York, compiled enzyme electrophoresis data, mostly unpublished, based on the electrophoretic mobility of 20 enzymes from samples of putative *F. virgata* and recognised a number of genetically distinct, or 'electrophoretic species'. Gullan *et al*. (2010) made an effort to correlate Nur's putative species with clades that they identified from their nucleotide sequence data (see below). This matching was greatly facilitated by the availability of some of Nur's slide-mounted voucher specimens deposited in the Coccoidea Collection of the United States National Museum, housed in Beltsville, Maryland. However, only part of Nur's collection of specimens and notes has been located and most of his data apparently were destroyed after his death in 2007 (Gullan *et al*., 2010).

The next indication that the widespread *F. virgata* was a complex of related species came from the molecular phylogenetic analysis of a small sample of *Ferrisia* specimens as part of a study to document *F. gilli* (Gullan *et al*., 2003). Despite limited sampling, that study found high genetic diversity among specimens identified morphologically as *F. virgata*. The most recent molecular phylogenetic study of *Ferrisia* (Gullan *et al*. 2010) analysed 42 samples of *Ferrisia* and found 10 clades representing 10 putative species, of which only three (clades G, H and J) were identified unambiguously as named species (*F. gilli*, *F. terani* Williams & Granara de Willink and *F. malvastra*, respectively) prior to genetic analysis. Six clades (B–F and I) were recognised among samples that would have been identified morphologically as *F. virgata* based on earlier taxonomic work (e.g., Williams & Granara de Willink, 1992; Williams, 1996), although two of these groups were identified *a priori* by Gullan *et al.* (2010) as representing potential new species. An additional clade (A) was identified *a priori* as a new species due to the distinctive morphology of the adult females. Furthermore, Gullan *et al*. (2010) showed that five of the 'electrophoretic species' recognised by Nur equated with four of their genetic clades. The discrepancy was due to Nur identifying two species among samples that fell in clade F of Gullan *et al*. (2010), although the latter authors pointed out that clade F was variable genetically and morphologically, and its taxonomic resolution required additional sampling. Gullan *et al*. (2010) also showed that several morphological features of the cuticular wax-exuding ducts and pores, which previously had been overlooked, were informative taxonomically and they illustrated these features for the adult females of clades A–F and I. A few traditionally used morphological features were shown to be uninformative in species recognition, especially among populations of *F. gilli*.

FIGURE 1. Mealybugs of *Ferrisia malvastra* (McDaniel) infesting purple lantana, *Lantana* sp. (Verbenaceae), El Centro, Imperial County, California. This painting was published as color plate X in H.L. McKenzie, *Mealybugs of California with Taxonomy, Biology, and Control of North American Species (Homoptera: Coccoidea: Pseudococcidae)*, Copyright 1967 by the Regents of the University of California, published by the University of California Press. It is reproduced here with the permission of the Regents of the University of California and from the original painting by Mary Foley Benson, D309, held in Special Collections, University of California Library, Davis. The mealybug species was identified as *F. virgata* (Cockerell) in the caption to the plate in McKenzie (1967) since *F. malvastra* was not recognised in 1967.

Currently, *Ferrisia* has 10 named species (Williams, 1996, 2004; Gullan *et al*., 2003) plus the additional six putative new species suggested by the work of Gullan *et al*. (2010). The present paper utilises the data of Gullan *et al*. (2010) as the foundation for a comprehensive morphological taxonomic revision of *Ferrisia*. We recognise eight new species of *Ferrisia,* five of them based on both molecular and morphological distinctness and three others based on morphology alone, and describe and illustrate these species based on the adult females. We resurrect one species, *Dactylopius dasylirii* Cockerell, from synonymy with *D. virgatus* Cockerell and describe and illustrate the adult female. We re-examine numerous putative specimens of *F. virgata* in light of our taxonomic reassessment, and redescribe and illustrate the adult female to allow easier identification of this pest species. We recognise morphological variation among adult females of *F. gilli*, and describe and illustrate a form commonly found on *Magnolia* in the eastern and southeastern United States. Descriptions and illustrations of another seven described species, namely *F. claviseta* (Lobdell), *F. malvastra*, *F. meridionalis* Williams, *F. multiformis* Granara de Willink,

F. quaintancii (Tinsley), *F. setosa* (Lobdell) and *F. terani*, have been published previously, but these are in older literature that can be difficult to access and so we provide revised illustrations of the adult females. For all seven species, we provide notes on the distribution, host plants and diagnostic morphology; we refer readers to published sources for further information. Full synonymies for the described species are available from Williams (1996) and from ScaleNet (Ben-Dov 2012). We also erect a new monotypic genus for the morphologically distinct species *F. floridana* (Ferris), known only from Florida and primarily on monocots, and provide a description of the genus and species plus a new illustration of the adult female.

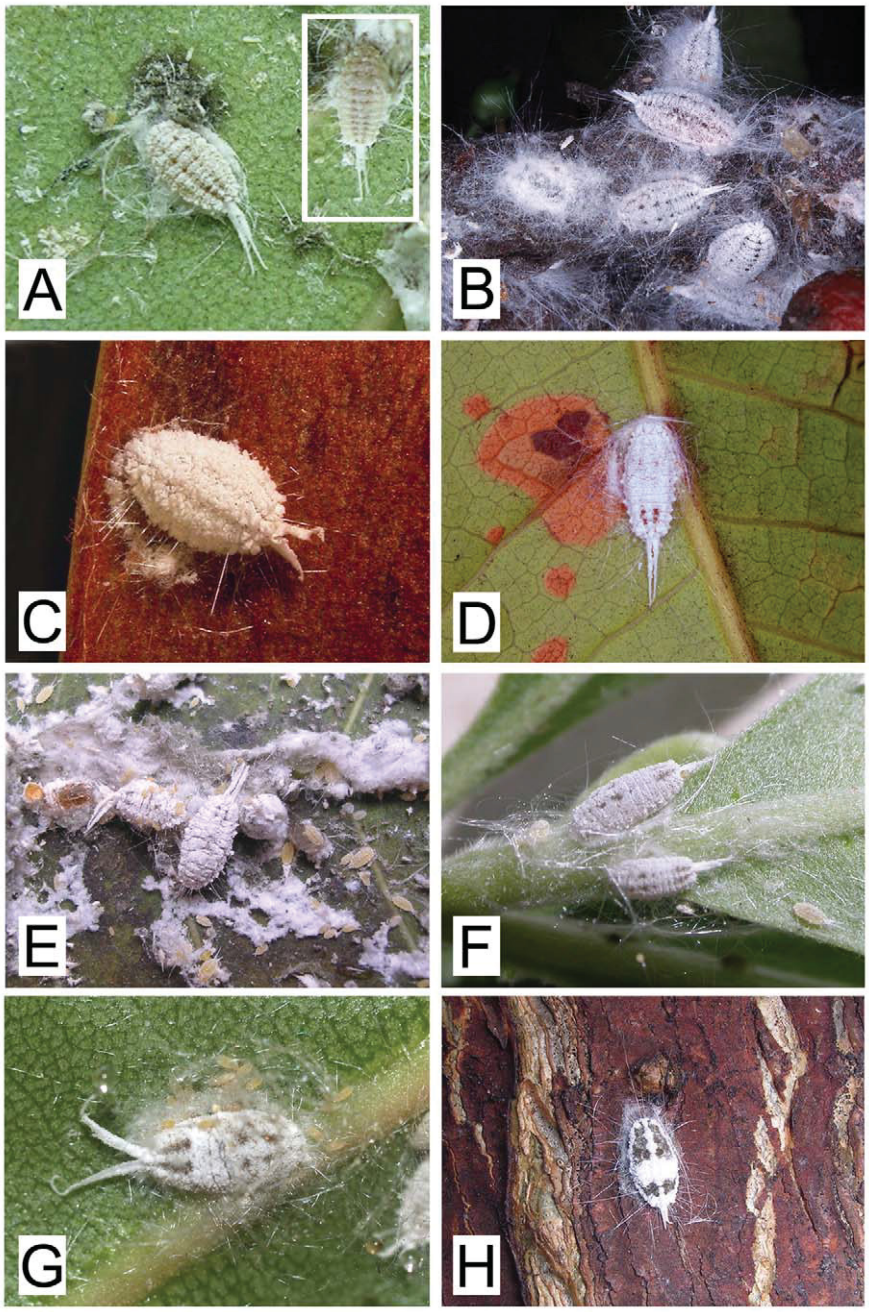

FIGURE 2. *Ferrisia* species on their host plants: A, two adult females of *F. dasylirii* (Cockerell) (one shown as an inset) on *Coccoloba uvifera*, Aruba (photo by PJG); B, adult females of type form of *F. gilli* Gullan on *Ilex vomitoria*, Auburn, Alabama, U.S.A. (photo by T. Kondo); C, mature adult female of *F. gilli* on leaf of *Magnolia grandiflora*, Davis, California, U.S.A. (photo by PJG); D, adult female of *F. kondoi* Kaydan & Gullan sp. n. on *Mangifera indica*, Cali, Colombia (photo by T. Kondo); E, adult females and many nymphs of *F. kondoi* sp. n. on unidentified Moraceae, Cali, Colombia (photo by T. Kondo); F, two adult females and several nymphs of *F. uzinuri* Kaydan & Gullan sp. n. on *Conocarpus* sp., Key Largo, Florida, U.S.A. (photo by PJG); G, one adult female with first-instar nymphs of *F. virgata* (Cockerell) on *Coccoloba uvifera*, Acapulco, Mexico (photo by T. Kondo); H, one adult female of *F. williamsi* Kaydan & Gullan sp. n. on trunk of *Erythrina* sp., Medellin, Colombia (photo by T. Kondo).

Materials and Methods

Specimens and depositories

Specimens obtained for this study, including the DNA voucher specimens of Gullan *et al*. (2010), were slide-mounted in Canada balsam using the method described in Williams & Granara de Willink (1992) except that xylene was used instead of clove oil. It is important not to overheat specimens of *Ferrisia* while clearing body contents in potassium hydroxide (KOH), otherwise the tubular ducts become distorted. In addition to the hundreds of specimens prepared specifically for this study, numerous slide-mounted specimens of *Ferrisia* were borrowed from the following museum collections: the Australian National Insect Collection (ANIC), CSIRO Ecosystem Sciences, Canberra, Australian Capital Territory, Australia; the Auburn University Coccoidea Collection (AUCC), Auburn, Alabama, U.S.A.; the Bohart Museum of Entomology (BME), University of California, Davis (UCD), California, U.S.A.; The Natural History Museum, London, U.K. (BMNH); the California State Collection of Arthropods (CSCA) of the California Department of Food and Agriculture, Sacramento, California, U.S.A.; the Florida State Collection of Arthropods (FSCA), Gainesville, Florida, U.S.A.; the Mississippi Entomological Museum (MEM), Mississippi State University, Mississippi, U.S.A.; Muséum National d'Histoire Naturelle (MNHN), Paris, France; and the United States National Collection of Coccoidea of the National Museum of Natural History (USNM), Smithsonian Institution, housed at the United States Department of Agriculture (USDA), Beltsville, Maryland. We have deposited recently-prepared slides, especially type specimens, in the ANIC, BME, BMNH, USNM, the entomological collection of the Instituto Miguel Lillo (IMLA), Tucumán, Argentina, and Museo Entomológico, Facultad de Agronomía, Universidad Nacional de Colombia (UNCB), Bogata D.C., Colombia.

Although we examined many of the vast number of slide-mounted specimens (mostly identified as *F. virgata*) housed in the USNM, we were not able to identify all of these specimens, nor include most of the collection data in this paper. Many collections were represented by limited material, sometimes the important diagnostic features were difficult to see due to the quality of the slide mounts and, after we established our species concepts near the end of this project, time precluded the effort required to revisit the USNM and restudy the slides.

We were unable to locate reared specimens of *Ferrisia* that Nur sent to Beardsley in the late 1970s (no specimens were found at the University of Hawaii and the Bernice P. Bishop Museum in Honolulu, Hawaii, where Beardsley worked and deposited specimens, respectively). Also, as noted by Schiefer (2000), the holotype of the species now known as *F. claviseta* is missing. Voucher specimens from the DNA work of Gullan *et al*. (2010) are housed in the BME. We were able to examine one or more type specimens for nine of the 10 named *Ferrisia* species as well as for five of the 10 junior synonyms of *F. virgata*. We document material examined for each species under the individual species entries. For type material of named species, we cite the specimen label data as they appear on the slides or, for dry material, the boxes, with each line of text from the original labels separated by a virgule and any comments that we have added placed in square parentheses.

Descriptive taxonomy

The morphological terms used in the descriptions are explained by Williams (1985a), Williams and Granara de Willink (1992) and Gullan *et al*. (2010). All measurements are maximum dimensions (e.g. body width was recorded at the widest part) and are expressed as the range. If available, at least 10 specimens per species were measured. Tarsal length excluded the claw. Setal lengths included the setal base. Counts of ventral oral-collar ducts were made for each segment or a group of segments if only one size of duct occurred on a species, but for some species smaller or shorter oral-collar tubular ducts also occur in clusters on the margins of the body, and these ducts were counted on a per cluster (or per side of body) basis; for the latter species, oral-collar tubular ducts on the rest of the venter often varied in length and width, with the longest ducts usually sparsely distributed along the submargin. For some species, we recognised a cluster of small oral-collar tubular ducts marginally anterior to abdominal segment II that we consider to represent the ducts of the remnant abdominal segment I. Often it is important to examine the details of the ventral oral-collar tubular ducts under oil immersion at x1000 magnification to be able to see the details of the discoidal pores associated with the duct openings. The size, shape and position of these discoidal pores are crucial to accurate identification of some species.

Each figure represents a generalised individual based on several of the specimens used for the description. The enlargements around the central drawing are not drawn to the same scale as each other. Although translucent pores on the hind legs are mostly on the dorsal surface, they are illustrated ventrally on the main figure for convenience.

The International Code of Zoological Nomenclature (ICZN 1999) requires lectotypes designated after 1999 to "contain an express statement of deliberate designation" (amended Article 74.7.3). We use the statement "here designated" to fulfill this requirement. Lectotypes have been designated where a name lacks a holotype or lectotype and unambiguous syntypes have been identified. The purpose is to provide stability of nomenclature, and designation is done in a revisionary context in agreement with the amended Recommendation 74G of Article 74.7.3.

We have registered each of the new names published in this paper with the Official Registry of Zoological Nomenclature (ZooBank) and cite the Life Science Identifiers (LSIDs) after the heading for each new name. Each LSID is a globally unique identifier for the nomenclatural act of naming a new taxon.

Relationships and distribution of *Ferrisia* species

Gullan *et al*. (2010) identified 10 clades as putative species within *Ferrisia* based on nucleotide sequence data, however, based on morphology, there are additional new species for which no fresh material was available for DNA analysis. Four of the clades recovered by Gullan *et al*. (2010) matched known, named species, as follows: Clade G = *F. gilli* Gullan, Clade H = *F. terani* Williams & Granara de Willink, Clade I = *F. virgata* (Cockerell) and Clade J = *F. malvastra* (McDaniel), although a more restricted concept of *F. virgata* was proposed. Six other putative species (Clades A to F) were not named by Gullan *et al*. (2010) as most were new to science. Here we describe or redescribe these six species and name them as follows: Clade A = *F. pitcairnia* sp. n., Clade B = *F. uzinuri* sp. n., Clade C = *F. kondoi* sp. n., Clade D = *F. cristinae* sp. n., Clade E = *F. williamsi* sp. n. and Clade F = *F. dasylirii* (Cockerell) stat. rev. The first five of the six species listed above are largely Neotropical in distribution and form a clade sister to *F. dasylirii* (Fig. 3).

Gullan *et al*. (2010) also identified new morphological features for recognising species of *Ferrisia*. Particularly informative characters of the adult female are the positions and characteristics of minute discoidal pores associated with both the ventral oral-collar tubular ducts and the sclerotised area surrounding each dorsal enlarged tubular duct, and the occurrence or distribution of clusters of ventral oral-collar tubular ducts on the body margin. For example, on the dorsum of adult females of *F. dasylirii* the minute discoidal pore(s) in the sclerotised area of each enlarged tubular duct never touches the rim of the duct opening, whereas the minute pore(s) associated with the enlarged tubular ducts of each of *F. pitcairnia*, *F. uzinuri*, *F. kondoi*, *F. cristinae* and *F. williamsi* nearly always touches the sclerotised rim of the duct opening. We recognise three other new species, *F. colombiana* sp. n. from Colombia, *F. ecuadorensis* sp. n. from Ecuador and *F. milleri* sp. n. from Puerto Rico, described below based solely on morphology of the adult females. These three species are known from relatively few collections, but it is clear that they are Neotropical in origin.

Molecular phylogenetic studies have suggested that *Ferrisia* is closely related to another New World genus, *Anisococcus* Ferris (Downie & Gullan 2004; Hardy *et al*. 2008). Adult females of these two genera share the presence of a minute pore or a cell-like structure (in *Anisococcus* called an 'auxiliary oral cell' by McKenzie (1967) and an 'auxiliary pore' by Williams & Granara de Willink (1992)) on or near the rim of the dorsal tubular ducts, although the ducts of *Anisococcus* have no sclerotised area or setae around the rim (McKenzie 1967; Williams & Granara de Willink 1992). In *Ferrisia* and the Mexican and South American species of *Anisococcus*, often there is more than one discoidal or auxiliary pore associated with each duct rim or sclerotised area. Furthermore the ventral oral-collar tubular ducts of most species of *Anisococcus* have an associated auxiliary pore or cell-like structure (rarely two) that resembles the discoidal pores associated with the ventral oral-collar tubular ducts of *Ferrisia*. Some species of *Pseudococcus* Westwood also have one or two minute discoidal pores adjacent to the rim of the oral-collar tubular ducts (Williams 2004), although *Pseudococcus* is only distantly related to *Anisococcus* and *Ferrisia* (Hardy *et al*. 2008). There appear to be no other morphological synapomorphies of *Anisococcus* and *Ferrisia*, but there is no recent systematic analysis of *Anisococcus* and at least one species (the unusual *A. abnormalis* McKenzie) may not be congeneric with the type species of the genus.

One unusual *Ferrisia* species, *F. floridana* from Florida, is so different from other *Ferrisia* species that its inclusion in *Ferrisia* makes it difficult to circumscribe the genus. Although molecular data are not available for this species, we have transferred it to a new genus, *Pseudoferrisia* **gen. n.**, in order to better delimit *Ferrisia* morphologically. We consider *Pseudoferrisia* to be the closest relative of *Ferrisia*.

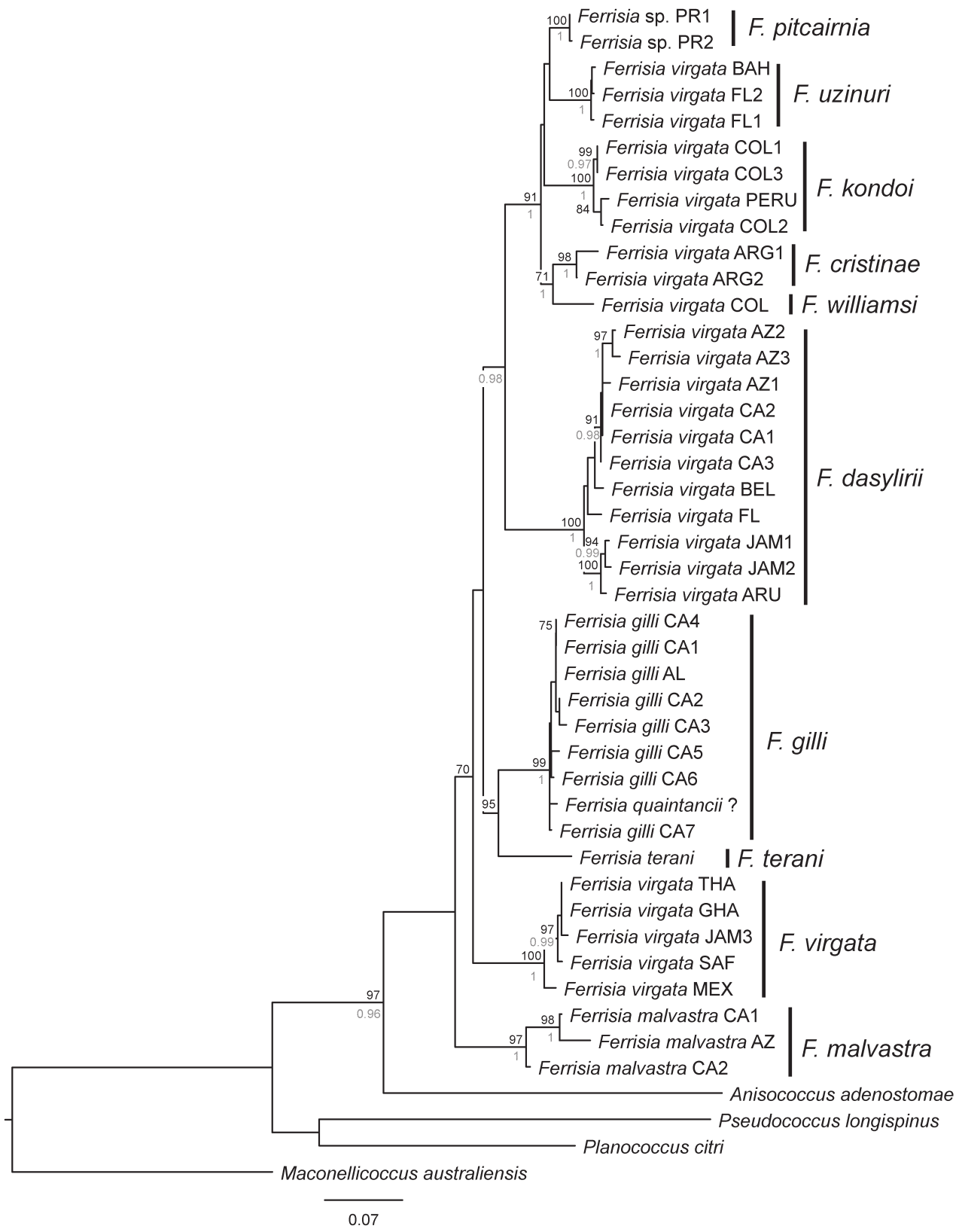

FIGURE 3. The Maximum Likelihood tree recovered from analysis of the combined data (COI, EF-1 a and 28S D2-D3), as reported in Gullan *et al*. (2010) but with species names associated with the former clades A–F and I. Bootstrap proportions (BS) are given above each node and posterior probabilities (PP) below each node. The terminal labelled '*Ferrisia quaintancii*?' was based on sequences from a nymph for which the species identity could not be confirmed.

Adult female mealybugs of *Anisococcus* can be identified to genus and species using keys in McKenzie (1967) and Williams & Granara de Willink (1992). Mealybugs of the genus *Pseudoferrisia* will key to *Ferrisia* in any published key to genera of mealybugs that includes *Ferrisia*. Adult females of these two genera can be distinguished mostly readily as follows:

1. Antennae 7 or 8 segmented; circulus present; cerarii confined to anal lobes, each lobe usually with 2 (rarely 3–5) cerarian setae; setae on sclerotised area around orifice of dorsal enlarged tubular ducts slender and bluntly tipped to slightly capitate; dorsal setae flagellate and bluntly-tipped to slightly capitate; oral-rim tubular ducts absent. . . . . *Ferrisia* Fullaway

- Antennae 6 segmented; circulus absent; anal lobe cerarii each with >5 cerarian setae, with cerarii or partial cerarii present on 2 or more segments anterior to anal lobes; setae on sclerotised area around orifice of dorsal enlarged tubular ducts slender spine-like; dorsal setae spine-like; oral-rim tubular ducts present on venter . . . . . *Pseudoferrisia* **gen. n.**

Genus *Ferrisia* Fullaway

Ferrisia Fullaway, 1923: 308, 311. **Type species:** *Dactylopius virgatus* Cockerell, by monotypy and original designation.
Ferrisiana Takahashi, 1929: 429. Unjustified replacement name; discovered by Morrison & Morrison, 1966: 78.
Ferrisa; Freidberg *et al*., 1989: 31. Misspelling of genus name.

The genus *Ferrisia* was established by Fullaway (1923) for *F. virgata* (then known as *Pseudococcus virgatus*), which at that time was considered to be widespread tropical species of probable Oriental origin. It is clear that Fullaway named this genus in honour of Gordon F. Ferris because he stated that Ferris (1919) had described the morphological characteristics and illustrated the important diagnostic features of *F. virgata*. Fullaway's (1923: 311) description of *Ferrisia* lists the diagnostic features of the genus as the possession of a single pair of cerarii, situated on the anal lobes, and "numerous peculiar wax ducts, which are unusually large and have their mouths surrounded by a small chitinized area bearing one to four small setae". These distinctive ducts are known now as 'enlarged tubular ducts' and are unique to *Ferrisia* and a new genus, *Pseudoferrisia* gen. n., that we erect in this paper for a peculiar species. The enlarged tubular ducts of these two genera differ in important characteristics, as listed in the key above and described in the Diagnosis for *Pseudoferrisia*.

For many years after 1929, *Ferrisia* was known by the replacement name *Ferrisiana* Takahashi but, as explained by Morrison & Morrison (1966) and McKenzie (1962, 1967), Takahashi's (1929) replacement of the name *Ferrisia* was unjustified. Takahashi had changed the genus name because he considered it to be a junior homonym of the very similar *Ferrissia* Walker, established in 1903 for a genus of molluscs. The current and past editions of the *International Code of Zoological Nomenclature* (Article 56.2 of the 4th edition (ICZN 1999)) state that even if the difference between two genus-group names is only one letter, they are not homonyms.

Generic description of adult female. Body elongate to oval, 1.3–5.5 mm long, 0.5–3.0 mm wide. Antennae almost always 8 segmented (sometimes 7 segmented in *F. milleri* and *F. pitcairnia*). Labium 3 segmented, always longer than wide. Posterior pair of spiracles always larger than anterior spiracles. Circulus quadrate, divided by an intersegmental line. Legs well developed, with or without translucent pores on hind coxa, femur and tibia; claw without a denticle; tarsal and claw digitules both capitate, claw digitules thicker than tarsal digitules. Posterior ostioles well developed; anterior ostioles usually more weakly developed than posterior pair, or absent. Anal lobes well developed. Anal ring typically with 6 anal ring setae, except for *F. setosa* with 12 or more setae.

Dorsum. Cerarii confined to anal lobes; each anal lobe usually with 2 enlarged conical setae (more on some specimens of *F. dasylirii, F. setosa and F. virgata*) plus associated cluster of trilocular pores and a few auxiliary setae. Body setae slender and flagellate, bluntly tipped to slightly capitate, and of various sizes. Trilocular pores each 3–5 μm in diameter, often slightly larger (4–5 μm diameter) than ventral trilocular pores (typically 3–5 μm), scattered over dorsum. Minute discoidal pores on dorsal submargin of head at base of antennal segment I, usually in small tight cluster of 3–8 pores (often difficult to see), and also associated with enlarged tubular ducts (generally present inside sclerotised area surrounding duct rim). Enlarged tubular ducts present (producing long filaments of glassy secretion in life), mostly on body margin and submargin in segmental clusters but often also present medially and submedially; duct opening of each tubular duct with a sclerotised rim surrounded by a circular sclerotised area bearing 0–3 (generally 1 or 2) minute discoidal pores (appearing as clear areas in cuticle) and with 1–7 (generally 3–5) bluntly-tipped to slightly capitate setae. Oral-collar tubular ducts and multilocular pores absent.

Venter. Body setae slender, bluntly tipped to slightly capitate, and of various sizes. Trilocular pores each 2.5–5.0 µm in diameter, scattered over surface. Minute discoidal pores scattered throughout body on venter, almost always associated with ventral oral-collar tubular ducts. Enlarged tubular ducts absent. Oral-collar tubular ducts of one or more sizes, varying in length and width, shortest ducts often present in marginal clusters at least on posterior abdominal segments; ducts on anterior abdomen and margins or submargins of posterior abdomen often associated with a minute discoidal pore (rarely 2 pores), usually appearing as a clear circular to oval area in cuticle. Multilocular disc pores generally present (absent in *F. meridionalis*) on posterior abdominal segments, especially around vulva.

Key to species of *Ferrisia* based on adult females

[NB. There can be substantial variation in certain mensural and meristic features of some species, perhaps due to conditions of development; a few species can be distinguished only by using a combination of features, and reliable identification requires well-mounted specimens and as many as possible to examine variation.]

1. Anterior ostioles absent 2
- Anterior ostioles present 5
2. Anal lobe cerarii each with 2–4 cerarian setae; anal ring with 12–36 setae; multilocular disc pores fewer than 6, usually 1–3 or absent . . . . . *setosa* (Lobdell)
- Anal lobe cerarii each with 2 cerarian setae; anal ring with 6 setae; multilocular pores present at least anterior and posterior to vulva and numbering more than 6. 3
3. Dorsal enlarged tubular ducts numbering >10 (usually 100–120); ventral oral-collar tubular ducts of more than one size, smaller ducts always present in clusters on body margin, at least on abdominal segments VII and VIII but sometimes on margins of most segments . . . . . *gilli* Gullan
- Dorsal enlarged tubular ducts numbering ≤10, sometimes absent; ventral oral-collar tubular ducts of one size only and never in clusters on body margin 4
4. Rim of each dorsal enlarged tubular duct, if ducts present, usually with 1 or 2 minute pores 2.5–5.0 µm in diameter and at least one duct with these minute pores paired; ventral oral-collar tubular ducts on abdominal segments present in small numbers (fewer than 50) . . . . . *claviseta* (Lobdell)
- Rim of each dorsal enlarged tubular duct, if ducts present, usually with 1 or 2 minute pores 2.0–3.0 µm in diameter but pores never in pairs; ventral oral-collar tubular ducts on abdominal segments numbering more than 50 . . . . . *quaintancii* (Tinsley)
5. Ventral oral-collar tubular ducts of at least 2 sizes, smaller ducts present singly or in segmental clusters on body margin, at least on last 2–3 abdominal segments 6
- Ventral oral-collar tubular ducts of one size, often very few, never in clusters on body margin 12
6. Cluster of small ventral oral-collar tubular ducts present marginally only on each of last 2 or 3 abdominal segments 7
- Cluster of small ventral oral-collar tubular ducts present marginally at least on each abdominal segment 11
7. Minute discoidal pores in sclerotised area of enlarged tubular ducts on dorsum never touching rim of duct opening (be careful not to confuse sockets of broken setae with discoidal pores) (Fig. 4A); minute discoidal pores associated with larger ventral oral-collar tubular ducts almost never touching rim of duct opening (Fig. 4B) 8
- Minute discoidal pores in sclerotised area of enlarged tubular ducts nearly always touching sclerotised rim of duct opening (Fig. 4C); minute discoidal pores often associated with larger ventral oral-collar tubular ducts and touching rim of duct opening (Fig. 4D) (except for some ducts of *F. cristinae* with pores not touching rim). 9
8. Discoidal pores associated with sclerotised area around rim of dorsal enlarged tubular ducts on anterior abdomen usually not touching outer margin of sclerotised area and almost never projecting out from margin (Fig. 4A-a); **other more variable features:** small oral-collar tubular ducts in marginal clusters on posterior abdomen with distal end rounded; antennae usually ≤600 µm, often ≤560 µm long; usually ≥15 multilocular disc pores on venter of abdominal segment VI, often forming at least a partial double row medially; translucent pores present on dorsal surface of hind coxa, especially posterolaterally, although often few in number; one or both anal lobes sometimes with an extra 1 or 2 conical cerarian seta, more slender than other 2 setae; outline of abdomen usually smoothly curvilinearly tapered to anal lobes . . . . . *virgata* (Cockerell)
- Most discoidal pores associated with sclerotised area around rim of dorsal enlarged tubular ducts on abdomen situated on outer margin of sclerotised area and often with pore and its surrounding sclerotisation projecting out from margin (Fig. 4A-b); **other more variable features:** small oral-collar tubular ducts in marginal clusters on posterior abdomen with distal end slightly tapered towards attachment of inner ductule (these ducts rare or clusters absent in some Neotropical specimens); antenna usually ≥600 µm long; usually ≤15 multilocular disc pores on venter of abdominal segment VI, typically forming a single, sometimes irregular, row; translucent pores either absent from dorsal surface of hind coxa or, if present, antennae ≥600 µm long; anal lobes usually with just 2 robust conical cerarian setae (except some specimens from *Dasylirion*); outline of abdomen slightly indented anterior to level of posterior ostioles in specimens from tropical locations . . . . *dasylirii* (Cockerell) **stat. rev.**

9. Translucent pores absent from hind coxa; each anal lobe with ≥60 trilocular pores; small oral-collar tubular ducts usually in tight segmental clusters on ventral margins of posterior 2 or 3 abdominal segments distributed 0–7 on each side of segment VI, 6–25 on each side of VII, 8–21 on each side of VIII . . . . . *kondoi* **sp. n.**
- Translucent pores numbering >20 on each hind coxa; each anal lobe with ≤50 trilocular pores; small oral-collar tubular ducts on ventral margins of posterior 2 or 3 abdominal segments either not forming tight clusters or in small clusters, each side of each segment usually with ≤6 ducts 10
10. Ventral oral-collar tubular ducts on abdominal submargin (not those in posterior marginal clusters) sometimes with 2 contiguous elliptical to elongate triangular discoidal pores in sclerotised rim of duct (check with 100x objective); hind coxa with translucent pores mostly 2.0–3.0 µm in diameter; from Colombia . . . . . *williamsi* **sp. n.**
- Ventral oral-collar tubular ducts on abdominal submargin (not those in posterior marginal clusters) often with a circular discoidal pore in sclerotised rim of duct or on derm nearby; hind coxa with translucent pores mostly 0.5–2.0 µm in diameter; from Argentina . . . . . *cristinae* **sp. n.**
11. Clusters of small oral-collar tubular ducts present on margins of head and each segment of thorax and abdomen; each small oral-collar duct with a rounded inner end; diameter of each discoidal pore associated with small oral-collar tubular ducts about same diameter as rim of duct opening. . . . . *milleri* **sp. n.**
- Clusters of small oral-collar tubular ducts present only on margins of each abdominal segment; each small oral-collar duct with inner end slanted towards attachment of inner ductule; diameter of each discoidal pore associated with small oral-collar tubular ducts much smaller than diameter of rim of duct opening . . . . . *ecuadorensis* **sp. n.**
12. Multilocular disc pores entirely absent . . . . . *meridionalis* Williams
- Multilocular disc pores present at least next to vulva 13
13. Multilocular disc pores present on abdominal segment VI in a distinct row of 3–10 pores 14
- Multilocular disc pores usually absent on abdominal segment VI, rarely 1 or 2 pores present 16
14. Dorsal enlarged tubular ducts generally numbering 90–110, present on all segments, at least on margins and medially . . . . . *uzinuri* **sp. n.**
- Dorsal enlarged tubular ducts generally numbering 10–30, generally restricted to body margin 15
15. Ventral oral-collar tubular ducts totalling 50–70; diameter of each discoidal pore associated with oral-collar tubular ducts about twice diameter of rim of duct opening; body length ≥1.8 mm long and ≥1 mm wide . . . . . *colombiana* **sp. n.**
- Ventral oral-collar tubular ducts totalling 13–23; diameter of each discoidal pore associated with oral-collar tubular ducts never twice diameter of rim of duct opening (usually about same diameter); body ≤1.8 mm long and ≤1.0 mm wide [on bromeliads] . . . . . *pitcairnia* **sp. n.**
16. Multilocular disc pores present only posterior to vulva; dorsal enlarged tubular ducts never numbering more than 2; hind trochanter + femur <300 µm . . . . . *multiformis* Granara de Willink
- Multilocular disc pores present on area anterior and posterior to vulva; dorsal enlarged tubular ducts totalling more than 100; hind trochanter + femur ≥300 µm 17
17. Body shape slender; dorsal enlarged tubular ducts on head and median area of abdominal segments with associated setae situated inside sclerotised area surrounding each duct . . . . . *terani* Williams & Granara de Willink
- Body shape broadly oval; dorsal enlarged tubular ducts on head and median area of abdominal segments with associated setae situated on edge of small sclerotised area surrounding each duct . . . . . *malvastra* (McDaniel)

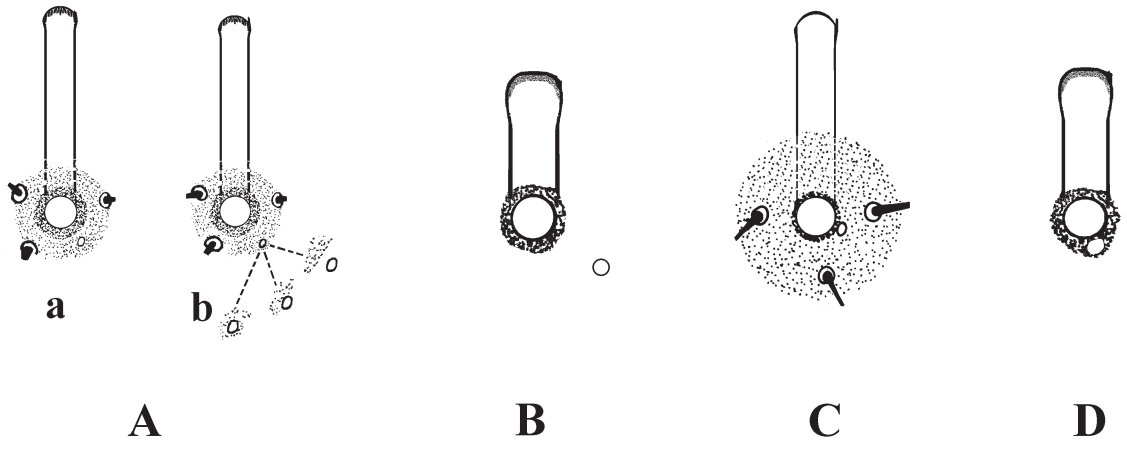

FIGURE 4. A, enlarged tubular duct with a minute discoidal pore not touching sclerotised rim of duct opening; pore position varies from fully within sclerotised area as in (a), to just touching outer margin of sclerotised area, to projecting outside of margin as in (b); B, ventral oral-collar tubular duct with a minute discoidal pore near, but not touching, sclerotised rim of duct opening; C, enlarged tubular duct with a minute discoidal pore touching sclerotised rim of duct opening; D, ventral oral-collar tubular duct with a minute discoidal pore touching sclerotised rim of duct opening. Only the outer part of each duct is shown; the fine inner ductule is not drawn and only setal bases are shown.

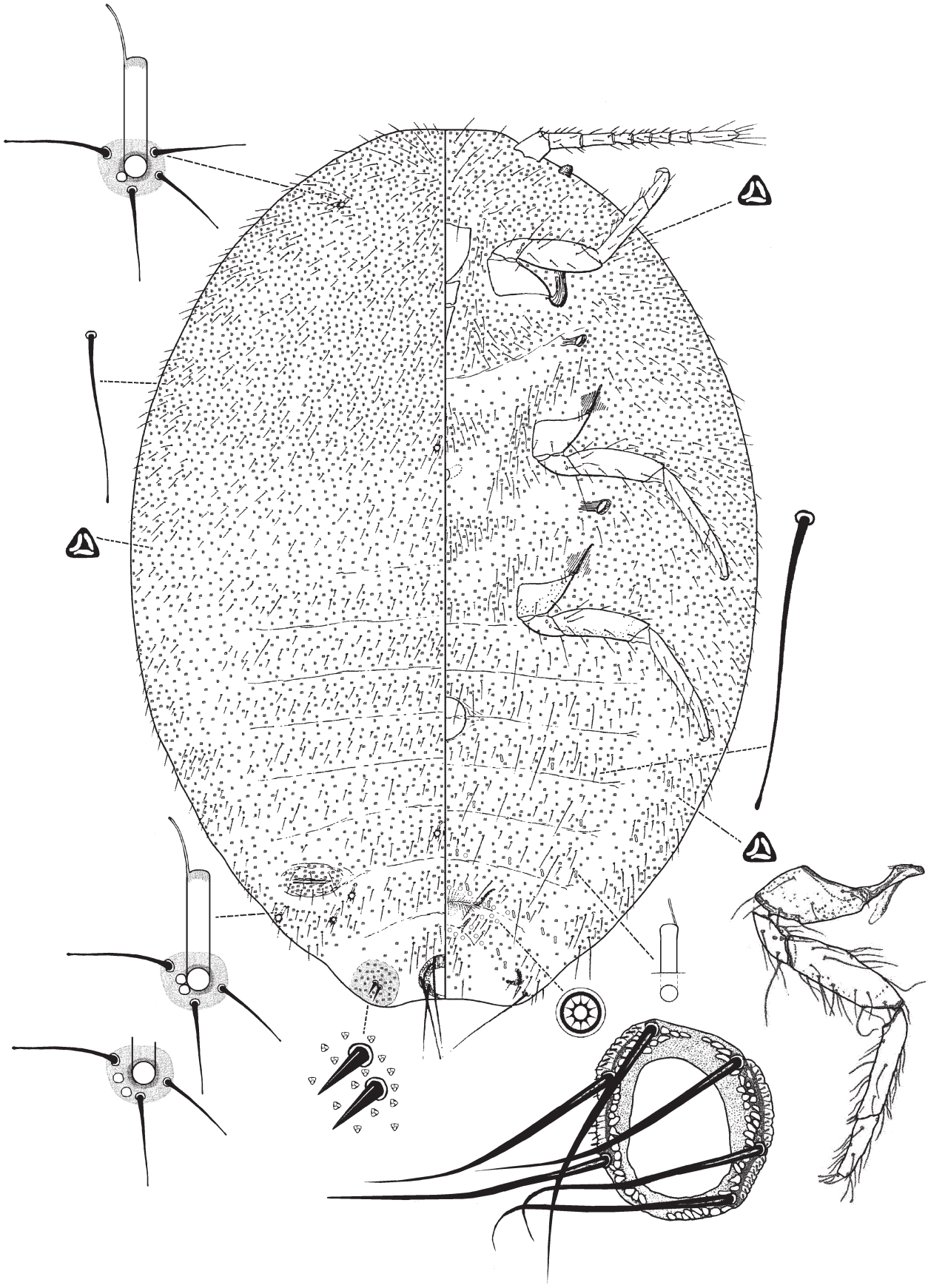

FIGURE 5. Adult female of *Ferrisia claviseta* (Lobdell). Modified from figure 33 of Ferris (1950) published by Stanford University Press, with the enlargements of the anal ring and hind leg from plate VIII of Lobdell (1930).

***Ferrisia claviseta* (Lobdell)**
(Fig. 5)

Trionymus claviseta Lobdell, 1930: 218.
Erium claviseta; Lindinger, 1935: 122. Change of combination.
Ferrisiana claviseta; Ferris, 1950: 89. Change of combination.
Ferrisia claviseta; McKenzie, 1967: 179. Change of combination.

This species is known only from the bark of *Celtis mississippiensis* (now *C. tenuifolia*; Cannabaceae) and *Ulmus* (Ulmaceae) from Mayhew (type locality) and Macon in Mississippi, U.S.A. (Lobdell 1930; Ferris 1950). Lobdell (1930) lists the type data as bark of hackberry, *C. mississippiensis*, from Mayhew, Mississippi, collected November 12, 1926 by Dr. M.R. Smith. The adult female was described and illustrated by Lobdell (1930) and Ferris (1950) (redrawn here, Fig. 5).

Williams (1996) listed the diagnostic features of this species and suggested that it might be the same as *F. quaintancii*. The adult female of *F. claviseta* differs from that of *F. quaintancii* in having fewer ventral oral-collar tubular ducts on the abdomen and usually more numerous enlarged tubular ducts on the dorsum of the posterior abdomen, although rarely more than five such ducts. However, one adult female of *F. claviseta* from the type locality has no enlarged tubular ducts anywhere on its body and another two adult females each have only one of these ducts on abdominal segment VII. A more significant difference between the two species is that the minute pores on the rim of the dorsal enlarged tubular ducts of the adult female of *F. claviseta* are larger (2.5–5.0 μm) than those of *F. quaintancii* (2.0–3.0 μm) and usually on at least one or two enlarged ducts of *F. claviseta* these minute pores are paired so that the two circular pores generally lie side by side (Fig. 5). This seems to be a unique feature of this species. Immature females of *F. claviseta* also have these double minute pores on the rim of some enlarged ducts but the pores are smaller (about 2 μm across).

We have examined paratypes of this species (in MEM), but the whereabouts of the holotype is unknown (Schiefer 2000). The paratypes are immature females (second- and third instar nymphs), but the MEM also has three slides with six adult females from the type locality (collected by M.R. Smith on September 2, 1927) and another six slides of 16 adult females and several nymphs (collected by M.R. Smith at Macon on August 23, 1927), and specimens on all nine slides are from the type host, hackberry, *C. mississippiensis*. The labels on two slides of immature paratype females state that the mealybugs were attended by "acrobatic ants", which were identified as *Crematogaster* sp. by Lobdell (1930). The BME also has four slides of nine adult females from the type host and collected by M.R. Smith but at Macon on 23 August 1927, and the USNM has two slides, one with two adult females from the same collection as in the BME and the other with one adult female from Mayhew but collected by Smith on September 2, 1927, and labelled as topotype (i.e., from the type locality). We were unable to obtain fresh material of *F. claviseta* for our molecular phylogenetic study (Gullan *et al.* 2010).

***Ferrisia colombiana* Kaydan & Gullan sp. n.**
(Fig. 6)
urn:lsid:zoobank.org:act:ED34BC70-7B40-43C2-96B0-9C6C896886A3

Type material. **Holotype**: adult ♀ (farthest from data label on slide with 2 paratypes), ex cut flower, COLOMBIA, Guacamaya, intercepted at Miami, 076163, 88-04646, 15.iv.1988, L. Chang (USNM). **Paratypes**: 2 adult ♀♀ on same slide as holotype (USNM).

ADULT FEMALE. Diagnosis. *Ferrisia colombiana* can be diagnosed by the following combination of features: absence of clusters of small oral-collar tubular ducts on ventral margins of abdominal segments; ventral oral-collar tubular ducts generally associated with 1 or 2 discoidal pores on derm around duct rim, each pore 4–5 μm in diameter and almost two times larger than duct opening; dorsal enlarged tubular ducts totalling 10–29 throughout dorsum, rim of each duct with 1 or 2 oval discoidal pores (sometimes 2 pores almost merged) usually associated with duct opening; number of multilocular disc pores on venter of abdominal segments as follows: V (0 or 1), VI (6–10), VII (14–22), and VIII + IX (8–14); both pairs of ostioles present and well developed.

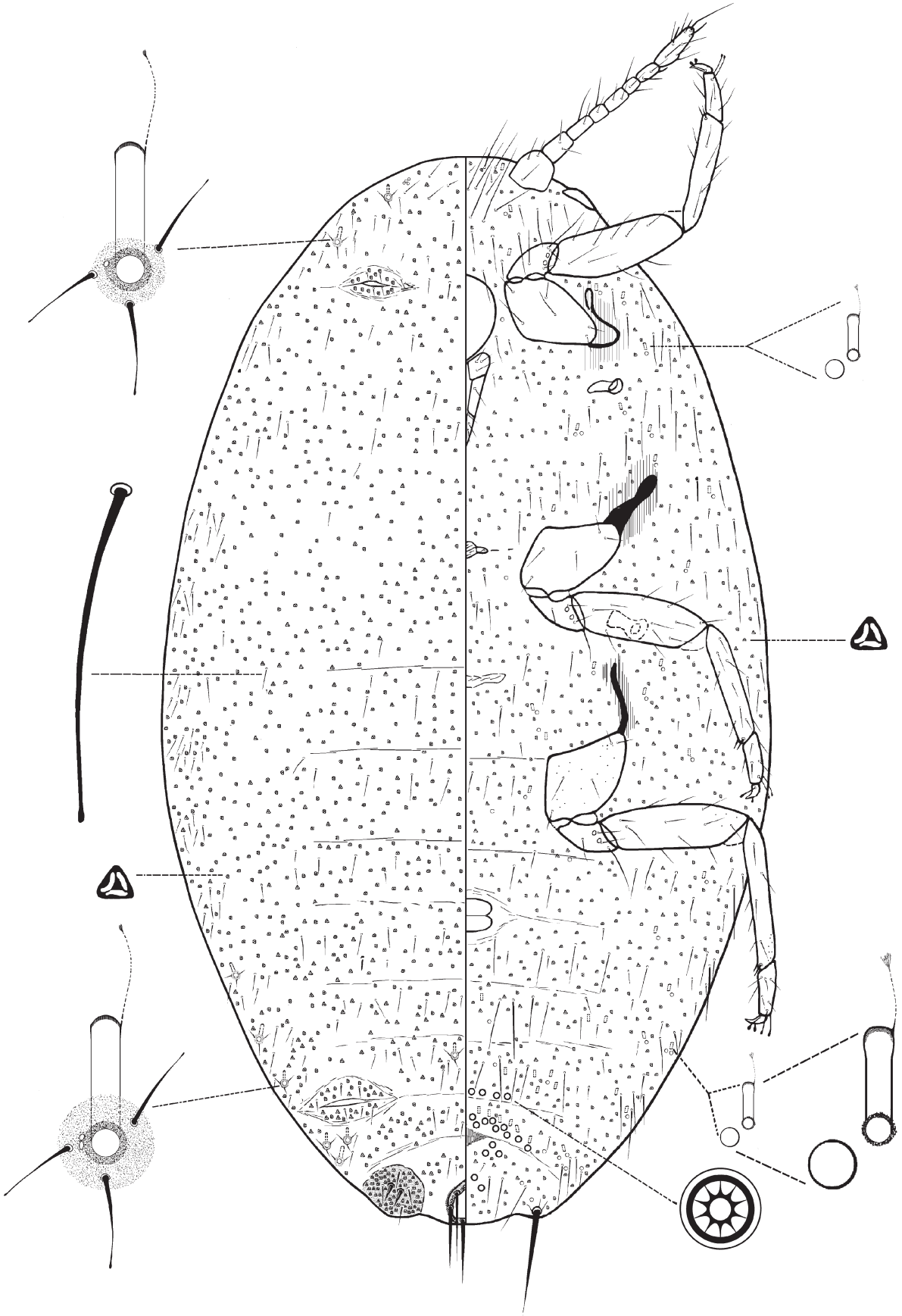

FIGURE 6. Adult female of *Ferrisia colombiana* Kaydan & Gullan sp. n.

Ferrisia colombiana can be readily distinguished from other species in the genus by having a small number of enlarged dorsal tubular ducts; lacking clusters of small marginal oral-collar tubular ducts; having large discodial pores associated with the ventral oral-collar tubular ducts; and by the presence of multilocular disc pores on abdominal segment VI. *Ferrisia colombiana* is most similar to *F. pitcairnia* but the adult female of *F. colombiana* is usually much larger than those of *F. pitcairnia*, and slide-mounted specimens of *F. colombiana* can be distinguished readily from *F. pitcairnia* by the presence of translucent pores on the hind legs (absent in *F. pitcairnia*) and by having a higher number of ventral oral-collar tubular ducts (59–75 in *F. colombiana* and 15–23 in *F. pitcairnia*).

Description of slide-mounted specimens (based on 3 specimens; Fig. 6)**.** Body elongate oval, 1.94–2.10 mm long (holotype 2.00 mm), 1.04–1.18 mm wide (holotype 1.18 mm). Eye marginal, 55–65 µm wide. Antenna 8 segmented, 410–425 µm long; apical segment 95–100 µm long, 27–30 µm wide. Clypeolabral shield 180–195 µm long, 175–182 µm wide. Labium 160–195 µm long, 120–155 µm wide. Anterior spiracles 70–75 µm long, 30–38 µm wide across atrium; posterior spiracles 70–85 µm long, 45–50 µm wide across atrium. Circulus quadrate, 120–150 µm wide, divided by an intersegmental line. Legs well developed; hind trochanter + femur 325–350 µm long, hind tibia + tarsus 330–375 µm long, hind claw 32–35 µm long. Ratio of lengths of hind tibia + tarsus to hind trochanter + femur 1.0–1.07; ratio of lengths of hind tibia to tarsus 2.28–2.66; ratio of length of hind trochanter + femur to greatest width of femur 3.71–4.38. Tarsal digitules subequal, each 47–53 µm long. Claw digitules subequal, each 30–38 µm long. Translucent pores present on hind legs on coxa, femur and distally on tibia, totalling 22–34. Ostioles: both pairs present; each anterior ostiole, with 26–34 trilocular pores and 4–8 setae; each posterior ostiole with 28–35 trilocular pores and 7–8 setae. Anal ring 67–83 µm wide, with 6 anal ring setae, each seta 155–175 µm long.

Dorsum. Anal lobe cerarii each with 2 conical setae, 34–38 µm long, with 29–38 trilocular pores and 3–7 auxiliary setae. Dorsal body setae short and slender, each 15–55 µm long. Trilocular pores each 3–4 µm in diameter. Enlarged tubular ducts totalling 10–29 on dorsum, each duct 25–33 µm long, 5–6 µm wide at mid-length, duct opening sclerotised, 7–10 µm in diameter, surrounded by a sclerotised circular rim 17–23 µm in diameter, enclosing 1 or 2 oval discoidal pores and 2–6 (generally 3 or 4) setae; if discoidal pores present on sclerotised rim adjacent to duct opening, sometimes 2 pores almost merged; setae associated with ducts each 20–40 µm long, usually either within sclerotised area around rim (especially on abdomen) or on edge of sclerotisation (especially on head); ducts distributed only marginally on head, thorax and abdominal segments; each segment with 0–2 ducts, but with 2 or 3 ducts on each side of abdominal segment VII.

Venter. Body setae slender, each 17–150 µm long, longest setae present medially on head; apical seta of anal lobe 210–240 µm long. Multilocular disc pores present on posterior abdominal segments: 0 or 1 pore on segment V, 6–10 on segment VI, 14–22 on segment VII, 8–14 on segments VIII + IX; each pore 7–10 (mostly 8–9) µm in diameter. Trilocular pores each 2.5–4.0 µm in diameter. Discoidal pores each 4–5 µm in diameter scattered on ventral surface and generally associated with oral-collar tubular ducts, generally 1 or 2 on each anal lobe. Oral-collar tubular ducts small, each 7–10 µm long, 2.5–3.0 µm wide, mostly associated with 1 discoidal pore (rarely 2), filament of duct not visible on specimens available; ducts totalling 59–75, distributed as follows: 14–25 on head and thorax, and on abdominal segments: 4–6 in total on I–III; 2–4 on IV; 8–10 on V; 5–13 on VI; 8–16 on VII; none on VIII.

Etymology. This species is named for the country of the only known specimens and should be treated as a noun in apposition.

Ferrisia cristinae Kaydan & Gullan sp. n.

(Fig. 7)

urn:lsid:zoobank.org:act:64440BCD-57A9-43CB-B766-7121F7681552

Type material. Holotype: adult ♀, ex *Tabebuia* sp., ARGENTINA, Tucumán, S. M. de Tucumán, v.2002, M.C. Granara de Willink (IMLA). **Paratypes:** 3 adult ♀♀, 1 third-instar ♀ (4 slides, including DNA voucher ♀♀ FBK010, PG88 & PG89), same data as holotype (BME, USNM); 1 adult ♀, 1 third-instar ♀ (2 slides, DNA voucher ♀♀ FBK011 & PG91), ex palta (avocado), *Persea americana*, ARGENTINA, Tucumán, El. Guayal Famaillá, V.2002, M.C. Granara de Willink (BME); 4 adult ♀♀ (4 slides), 5 third-instar ♀♀, 7 second-instar

nymphs, 3 first-instar nymphs (3 slides), ex *Tabebuia* sp., ARGENTINA, Tucumán, S. M. de Tucumán, xi.2008, M.C. Granara de Willink (2 adult ♀♀ in BME, I adult ♀ in USNM, rest in IMLA).

Other material examined (may not be conspecific with Argentine specimens and measurements not included in the description below): 1 adult ♀, ex *Pleurothallis*, BRAZIL, Hoboken, 29.x.1940, Adams coll., Hoboken 630 (USNM); 2 adult ♀♀, ex *Pleurothallis*, BRAZIL, Hoboken, 30.x.1940, Prince coll., Hoboken 636 (USNM); 2 adult ♀♀, ex leaves of *Schinus terebinthifolius*, BRAZIL, Bahia, Salvador, vi.1954, #4871 (USNM); 5 adult ♀♀ (1 slide), ex *Codiaeum variegatum* #95, BRAZIL (no locality specified), 19.ix.1997, A.L.B.G. Peronti, 9801139 (USNM); 1 adult ♀, carried by wasp; COSTA RICA, Hacienda Ciruelas, 28 km NW of Cañas, 23.i.1970, M. Kosztarab, C-561 (USNM); 1 adult ♀, ex *Inga* sp., COSTA RICA, Prov. Heredia, Rio Frio, 8.i.1970, M. & M. Kosztarab, Herb C416a (USNM); 1 adult ♀, ex *Dracaena* leaf, COSTA RICA, intercepted at Miami 15974, 5.iv.1977, E.M. Jones (USNM); 1 adult ♀, ex *Bactris* stem, DOMINICAN REPUBLIC, intercepted at Miami 28955, 3.viii.1981, K. Niédzwiadek (USNM); 1 adult ♀, ex leaf of Aceraceae, PARAGUAY, intercepted at Miami 085560, 31.v.1989, D. Alborn, 89-7043 (USNM); 2 adult ♀, ex *Zingiber* sp., TRINIDAD, 18.iii.1972, R. Heliczer, JFKIA 9756 (USNM).

ADULT FEMALE. Diagnosis. *Ferrisia cristinae* can be diagnosed by the following combination of features (based on 5 type females only): presence of a few (1–6 per segment) small oral-collar tubular ducts usually scattered on ventral margins of last 2–3 abdominal segments; ventral oral-collar tubular ducts generally with a minute discoidal pore touching rim of duct opening (sometimes slightly away from duct opening); dorsal enlarged tubular ducts totalling 95–113 throughout dorsum, with 1 or 2 oval discoidal pores sometimes adjacent to rim of each duct opening; number of multilocular disc-pores on venter of abdominal segments as follows: segment VI (7 or 8), VII (15–22), and VIII + IX (13–19); anal lobe cerarii each with 2 conical setae; both pairs of ostioles present and pairs well developed; translucent pores scattered on dorsal surface of at least hind coxa.

Ferrisia cristinae is most similar to specimens of *F. williamsi* from Colombia, but in *F. cristinae* the discoidal pores associated with ventral oral-collar tubular ducts often do not touch the duct rim (in *F. williamsi* any minute discoidal pores associated with the ducts always touch the rim of the duct opening); furthermore, the translucent pores on the hind coxa of *F. cristinae* are mostly 0.5–2.0 µm in diameter (mostly 2.0–3.0 µm in diameter in *F. williamsi*). Additional specimens of these two species need to be identified based on DNA data and the morphology then studied more closely. *F. cristinae* can be distinguished readily from *F. kondoi* by having scattered translucent pores on the hind coxa (none on hind coxa of *F. kondoi*), fewer trilocular pores on the anal lobes (35–45 on each lobe of *F. cristinae*; 58–62 on *F. kondoi*), and fewer ventral oral-collar ducts on the body (56–75 on *F. cristinae*; 87–113 on *F. kondoi*; excluding those on the posterior abdominal margin) but especially on the posterior abdominal segments where the number of ventral oral-collar tubular ducts is less than half of the number present in *F. kondoi*. The adult female of *F. cristinae* differs from that of *F. virgata* in the position of the discoidal pores, having 1 or 2 pores adjacent to the opening of most dorsal enlarged ducts and ventral oral-collar tubular ducts (discoidal pores never adjacent to duct openings in *F. virgata*). *F. cristinae* can be separated from *F. milleri* and *F. ecuadorensis* by the absence of small clusters of oral-collar tubular ducts on the head, thorax and anterior abdominal segments. *F. cristinae* can be distinguished readily from *F. uzinuri* by having clusters of small oral-collar tubular ducts on the ventral margins of the posterior abdominal segments (absent in *F. uzinuri*).

Description of slide-mounted specimens (based on 5 type females only; Fig. 7). Body 2.06–4.20 mm long (holotype 2.30 mm), 1.12–2.58 mm wide (holotype 1.40 mm). Eye marginal, 60–85 µm wide. Antenna 8 segmented, 610–670 µm long; apical segment 122–125 µm long, 30–32 µm wide. Clypeolabral shield 165–170 µm long, 180–190 µm wide. Labium 195–200 µm long, 120–130 µm wide. Anterior spiracles 67–80 µm long, 36–45 µm wide across atrium; posterior spiracles 75–90 µm long, 60–65 µm wide across atrium. Circulus quadrate, 165–190 µm wide, divided by an intersegmental line. Legs well developed; hind trochanter + femur 460–490 µm long; hind tibia + tarsus 490–500 µm long; hind claw 35–42 µm long. Ratio of lengths of hind tibia + tarsus to hind trochanter + femur 1.04–1.07; ratio of lengths of hind tibia to tarsus 3.0–3.16; ratio of length of hind trochanter + femur to greatest width of femur 4.71–5.20. Tarsal digitules subequal, each 55 µm long. Claw digitules subequal, each 40 µm long. Translucent pores present on hind coxa, and usually also on femur and tibia, totalling 80–93 on all segments combined; with 22–55 on each hind coxa. Ostioles: both pairs present; each anterior ostiole poorly developed, with 17–19 trilocular pores and 4–6 setae; each posterior ostiole with 30–47 trilocular pores and 7–8 setae. Anal ring 110–140 µm wide, with 6 anal ring setae, each seta 160–230 µm long.

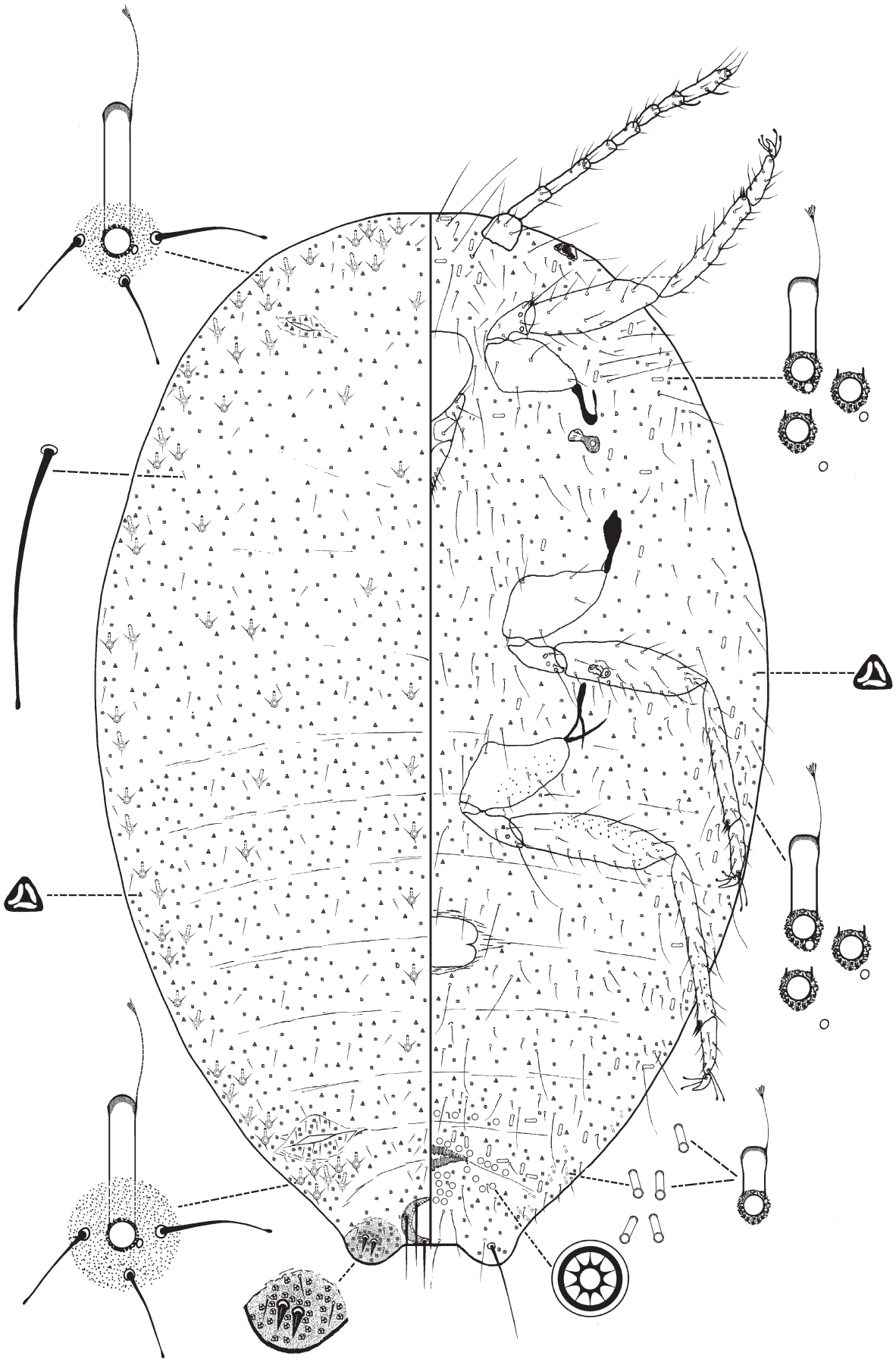

FIGURE 7. Adult female of *Ferrisia cristinae* Kaydan & Gullan sp. n.

Dorsum. Anal lobe cerarii each with 2 conical setae, 25–35 µm long, with 35–45 trilocular pores and 2 or 3 auxiliary setae. Dorsal body setae slender, each 15–65 µm long. Trilocular pores each 4–5 µm in diameter. Enlarged tubular ducts totalling 95–113 on dorsum, each duct 30–38 µm long, 5.0–6.5 µm wide at mid-length, rim of duct opening sclerotised, 7.0–8.0 µm wide, surrounded by a sclerotised circular area 17.5–35.0 µm wide, enclosing 0–2 oval discoidal pores (each generally adjacent to duct opening) and with 1–5 (generally 2–4) setae, each 20–45 µm long, usually within circular sclerotised area closer to edge than to duct opening (especially on abdomen) or on edge of sclerotised area (especially on head); ducts distributed marginally in clusters of 2–5 on head and thorax, on margins of all abdominal segments in groups of 2–4, but with 7–8 ducts on each side of abdominal segment VII, and also 1–2 medially to submarginally on head and thorax, 1–2 medially on each abdominal segment.

Venter. Body setae slender, each 15–180 µm long, longest setae medially on head; apical seta of anal lobe approximately 300 µm long (apex broken on all specimens). Multilocular disc pores present on posterior abdominal segments only: 7–8 pores on segment VI, 15–22 on segment VII, 13–19 on segments VIII + IX; each pore 8–10 µm in diameter. Trilocular pores each 3–5 µm in diameter. Minute discodial pores each 2.0–2.5 µm in diameter, almost always associated with oral-collar tubular ducts, with 1 or 2 pores either touching rim of or near to most oral-collar tubular ducts. Oral-collar tubular ducts on most of venter (excluding margins of posterior abdomen) each 7.5–12 µm long, 2.5–3.5 µm wide, totalling 56–75, distributed as follows: 23–38 on head and thorax, and on abdominal segments: 7–10 total on segments I–III; 2–3 on IV; 2–4 on V; 7–9 on VI; 9–12 on VII; 0–2 (mostly 0) on VIII. Small oral-collar tubular ducts each 7.0–8.0 µm long, 3.0–3.8 µm wide, distributed on margins of abdominal segments as follows: 0–1 on each side of segment VI; 3–6 on each side of VII; 3–6 on each side of VIII, ducts on each segment generally scattered, not forming a tight cluster.

Etymology. This species is named in honour of Dr Cristina Granara de Willink, who collected the type specimens of this species, and who has made significant contributions to knowledge of scale insects in South America and especially Argentina.

Ferrisia dasylirii (Cockerell) stat. rev.

(Figs 2A, 8)

Dactylopius dasylirii Cockerell, 1896: 202.
Pseudococcus dasylirii; Fernald, 1903: 101. Change of combination.
Ferrisia virgata (Cockerell); incorrect synonymy by Ferris, 1953a: 362.

Type material (examined). Lectotype: *Dactylopius dasylirii* Cockerell [designated by Williams (1996)]: adult ♀: on slide with 5 other adult ♀♀, labels: "Dactylopius / dasylirii / Dasylirion / wheeleri / Organ, N.M. / Sept. 27 '96 / (Cockerell) / TYPE" "7279" and "147/11" (USNM). **Paralectotypes:** 5 adult ♀♀, on same slide as lectotype, and second slide with 25 first-instar nymphs, with same labels as lectotype slide (USNM); 6 adult ♀♀ (6 slides), mounted from the type material and with different label: "Pseudococcus / dasylirii (Ckll.) / on Dasylirion wheeleri / Organ, N.M. alt. 5100 ft / Sept. 27,1896 / Tnsly colr. (7279)" (USNM) [the label on the latter 6 slides is erroneous in that the collection was not made by Tinsley].

Cockerell (1896) described *Dactylopius dasylirii* from sotol, *Dasylirion wheeleri* (Ruscaceae, or sometimes placed in Nolinaceae), from a collection that he made in New Mexico near the community of Organ [at 1555 m; 32°26'N 106°36′W]. We have examined a number of collections taken from this host plant in New Mexico and Arizona. The adult females often have rather thick setae associated with the sclerotised area surrounding the dorsal enlarged ducts. Otherwise they resemble adult females from collections on a range of host plants in California that we are treating as the same species and, which like the samples from *Dasylirion* in Arizona, usually have very few small ventral oral-collar tubular ducts on the margins of the posterior abdominal segments. We have restricted our redescription of *F. dasylirii* to specimens collected in the southwest USA, but assign many morphologically similar specimens to this species pending further study, especially using freshly collected material and more variable genetic markers. Gullan *et al.* (2010) sequenced specimens from Aruba, Belize, Jamaica and Florida (USA) that they considered to be conspecific with populations from Arizona and California (Fig. 3), although they show some morphological (see below under Variation) and genetic differences from the latter populations. Nur (in lit to J.W. Beardsley) referred to a Californian population on oleander (*Nerium* sp.) from Calexico in Imperial County as

species FO and considered it distinct from specimens from Florida ex *Coccoloba uvifera* that he called species FF. Our specimens from Florida, Aruba, Belize and Jamaica resemble Nur's voucher specimens of FF in having few or no translucent pores on the hind coxa (many specimens of *F. dasylirii* from Arizona and California have at least some translucent pores on the hind coxa) and our specimens ex *C. uvifera* from Aruba (Fig. 2A) further resemble Nur's FF in having fewer than 10 (usually ≤7) multilocular disc-pores on abdominal segment VI and few small oral-collar tubular ducts in clusters on the margins of the posterior abdominal segments.

Material used for description (in addition to type material): USA: 2 adult ♀♀ (2 slides, including FBK018), ex *Dasylirion wheeleri*, Arizona, Santa Catalina Mountains, Mt Lemmon, near Molino Basin, 3.ix.2002, S. Prchal (BME); 8 adult ♀♀ (8 slides), ex *D. wheeleri*, Arizona, Santa Catalina Mountains, Mt Lemmon, near "Prison Camp", 3.ix.2002, S. Prchal (BME); 16 adult ♀♀ (16 slides, including FBK019), ex *Dasylirion* sp., Arizona, Pima Co., Oro Valley, Orange Grove Road, 24.viii.2002, J.F & D.R. Miller (BME); 7 adult ♀♀ (7 slides, including FBK012), ex *D. wheeleri*, Arizona, Bisbee, 1429 Franklin St, 31º24'34"N, 109º55'58"W., 5200 ft [1585 m], 20 viii.2005, A.S. & N. Menke, (BME); 103 adult ♀♀ (12 slides), ex *D. wheeleri*, Arizona, Tucson, 10.ix.1943, L.P. Wehrle, plus 5 adult ♀♀ (5 slides) from same collection (Wehrle Coll. # 1448) slide-mounted by P.J. Gullan from dry collection in 2002 (BME); 10 adult ♀♀ (5 slides), ex *Dasylirion* sp., Arizona, Pima Co., 1 mile [1.6 km] S of Gardner Canyon Rd & Highway 83, 21.vii.1974, T. Halstead (CSCA & USNM); 4 adult ♀♀ (4 slides, including FBK026), ex mulberry (*Morus* sp.), California, El Centro 2270, Sandalwood Drive, 17.x.2001, B. Roltsch (BME); 2 adult ♀♀ (2 slides, including FBK025), ex carob (*Ceratonia siliqua*), California, Calexico, 1018 Sixth St., 29.x.2001, B. Roltsch (BME); 6 adult (3 slides), ex sotol [*D. wheeleri*], New Mexico, Doña Ana Co., Las Cruces, 13.xi.1980, G.L. Nielsen (CSCA).

Material sequenced and/or measured but not used for description: 6 adult ♀♀ (6 slides, including FBK013), ex *Coccoloba uvifera* (Polygonaceae), ARUBA, Baby Beach, 12º24'N, 69º53'W, 19.vii.2005, P.J. Gullan (BME); 3 adult ♀♀ (3 slides, including FBK009), ex ornamental shrub, BELIZE, Belize District, Cay Caulker, 4.vi.2000, D.R. Miller (BME); 26 adult ♀♀ (26 slides, including FBK001), ex *Annona squamosa* (Annonaceae), JAMAICA, Kingston, East Street, 7.ix.2003, T. Kondo (3 slides ANIC, 19 BME, 2 USNM, 2 UNCB); 1 adult ♀ (1 slide, FBK002), ex *Anthurium* sp. (Araliaceae), JAMAICA, Ocho Rios, in garden of Crane Ridge Hotel, 4.ix.2003, T. Kondo & P.S. Cranston (BME); 7 adult ♀♀ (7 slides), ex *Acacia sphaerocephala* (Fabaceae), MEXICO, Oaxaca, Temascal, 1.v.1964, D.H. Janzen (BME); 6 adult ♀ (6 slides, including FBK006), ex *Codiaeum variegatum* var. *pictum* (Euphorbiaceae), USA, Florida, Orange Co., Apopka, 3239 Kelly Park Rd, 8.x.2001, K. Gonzalez (BME).

In addition to the above lists, we identified specimens of *F. dasylirii* from the following countries: Bahamas, Brazil, Chile, Colombia, Costa Rica, Cuba, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, USA [Arizona (AZ) counties: Maricopa and Pima; California (CA) counties: Alameda, Fresno, Imperial, San Bernardino, San Diego, San Joaquin, San Francisco (under glass) and San Mateo; Florida intercepted in quarantine in CA; Hawai'i: Honolulu; New Mexico: Doña Ana Co.; Texas: Cameron Co.] and Venezuela, on the following plant species: *Acacia greggii* (Fabaceae), *Acalypha* sp. (Euphorbiaceae), *Albizia* sp., *A. julibrissin* (Fabaceae), *Alpinia purpurata* (Zingiberaceae), *Alternanthera* sp. *(*Amaranthaceae*)*, *Ananas comosus* (Bromeliaceae), *Andira inermis* (Fabaceae), *Annona* sp., *A. squamosa* (Annonaceae), *Brassica oleracea* (Brassicaceae*), Cattleya* sp. (Orchidaceae), *Codiaeum* sp. (Euphorbiaceae), *Cocos nucifera* (Arecaceae), *Cordyline fruticosa* (Liliaceae), *Couroupita guianensis* (Lecythidaceae), *Croton* sp. (Euphorbiaceae), *Cucumis melo* (Cucurbitaceae), *Dasylirion* sp. (Ruscaceae), *Dieffenbachia* sp. (Araceae), *Dracaena marginata, D. massangeana* (Ruscaceae), *Elaeis guineensis* (Arecaceae), *Eryngium foetidum* (Apiaceae), *Fernaldia* sp. (Apocynaceae), *Gossypium* sp. (Malvaceae), *Hoya* sp. (Apocynaceae), *Gossypium* sp. (Malvaceae), *Hibiscus* sp. (Malvaceae), *Heliconia* sp. (Heliconiaceae), *Jatropha berlandii* (Euphorbiaceae), *Lantana camara (*Verbenaceae), *Mangifera indica* (Anacardiaceae), *Morus* sp. (Moraceae), *Musa* sp. (Musaceae), *Nephelium lappaceum* (Sapindaceae), *Nephthytis* sp. (Araceae), orchid sp. (Orchidaceae), *Philodendron* sp. (Araceae), *Pithecellobium dulce* (Fabaceae), *Poinsettia pulcherrima* (Euphorbiaceae), *Polyscias fruticosa* (Araliaceae), *Pothos* sp. (Araceae), *Psidium guajava* and *Psidium* sp. (Myrtaceae), *Saintpaulia* sp. (Gesneriaceae), *Syngonium* sp. (Arecaceae), *Terminalia catappa* (Combretaceae), *Theobroma cacao* (Malvaceae), Violeta (Violaceae), *Yucca* sp.(Agavaceae), *Zingiber* sp. and *Z. officinale* (Zingiberaceae).

ADULT FEMALE. Diagnosis. *Ferrisia dasylirii* can be diagnosed by the following combination of features: presence of clusters of small oral-collar tubular ducts on ventral margins of last 2 or 3 abdominal segments; ventral

oral-collar tubular ducts frequently associated with a minute discoidal pore which almost never touches rim of duct, usually distant from rim by at least half length of duct; dorsal enlarged tubular ducts totalling 54–114 throughout dorsum, rim of each duct often with 1 or 2 oval discoidal pores usually touching outer margin of sclerotised area and sometimes projecting out from margin (on some specimens these discoidal pores are rare); multilocular disc-pores on venter of abdominal segments VI (1–19) (usually fewer than 15 in one irregular row), VII (13–36), and VIII + IX (13–22); anal lobe cerarii each with 2 conical setae (except some specimens from *Dasylirion* (Fig 8b); both pairs of ostioles present; antennae usually ≥600 µm long (apical antennal segment ≥120 µm long); most specimens of *F. dasylirii* lack translucent pores on the hind coxa, and all examined specimens from the type locality lack these pores. However on adult females from two of the sequenced collections from California (CA 2 and CA 3) and one of the collections from Arizona (AZ 2) translucent pores are present and fairly numerous, and in a second sequenced Arizona collection (AZ 3) 12 of 16 females lack the pores, three females have a few pores on just one coxa and a fourth female has pores on both coxae.

Ferrisia dasylirii is most similar to *F. virgata* as both species have ventral oral-collar tubular ducts of more than one size, clusters of small oral-collar tubular ducts on the ventral margins of the last 2–3 abdominal segments, and a minute discoidal pore usually near each enlarged dorsal tubular duct and most ventral oral-collar tubular ducts but never touching the rim of the duct opening. *F. dasylirii* can be distinguished readily from *F. virgata* by the following features: (i) discoidal pores are on the outer margin of the sclerotised area around the rim of the dorsal enlarged tubular ducts on the abdomen (Fig. 4Ab) and often each pore and its surrounding sclerotisation projects out from the margin (in *F. virgata* discoidal pores associated with the sclerotised area around the rim of the dorsal enlarged tubular ducts on the abdomen usually not touching the outer margin of the sclerotised area and almost never projecting out from margin; Fig. 4Aa); (ii) small oral-collar tubular ducts in clusters on the posterior abdomen with distal end of each duct slightly tapered towards the attachment of inner ductile (in *F. virgata* the distal end of each duct is rounded); (iii) antennae usually ≥600 µm long with apical segment 120–150 µm long (usually ≤600 µm long with apical segment 105–125 µm long in *F. virgata*); (iv) venter of abdominal segment VI usually with ≤15 multilocular disc pores typically forming a single, sometimes irregular, row (in *F. virgata* ≥15 pores, usually forming at least a partial double row medially); (v) translucent pores usually absent on hind coxa (in *F. virgata* present on dorsal surface of hind coxa, especially posterolaterally, although often few in number); (vi) each anal lobe with only 2 cerarian setae except some specimens from *Dasylirion* (in *F. virgata* sometimes with an extra 1–2 conical cerarian seta(e) that is/are more slender than the other 2 setae). *F. dasylirii* is also very similar to *F. cristinae*, *F. kondoi* and *F. williamsi* (which have ventral oral-collar tubular ducts of more than one size, and clusters of small oral-collar tubular ducts on the ventral margins of the last 2 or 3 abdominal segments), however, *F. dasylirii* can be readily distinguished from the other three species by the position of the minute discoidal pores associated with ducts, which in *F. dasylirii* are always near the enlarged tubular ducts and ventral oral-collar tubular ducts but never touch the rim of the duct opening (discoidal pores always adjacent to duct openings in *F. cristinae*, *F. kondoi* and *F. williamsi*). *F. dasylirii* is also close to *F. milleri* and *F. ecuadorensis* but can be separated from these two species by the absence of clusters of small oral-collar tubular ducts on the head, thorax and abdominal segments.

Description of slide-mounted specimens (based on measured specimens listed above and excluding those from Aruba, Belize, Jamaica, Mexico and Florida (USA); Fig. 8). Body elongate oval, 3.14–5.30 mm long, 1.36–2.86 mm wide. Eye marginal, 63–85 µm wide. Antenna 8 segmented, 580–780 µm (generally ≥600 µm) long; apical segment 120–150 µm long, 30–40 µm wide. Clypeolabral shield 190–218 µm long, 170–200 µm wide. Labium 175–215 µm long, 120–188 µm wide. Anterior spiracles 60–90 µm long, 43–50 µm wide across atrium; posterior spiracles 87–110 µm long, 50–75 µm wide across atrium. Circulus quadrate, 150–220 µm wide, divided by an intersegmental line. Legs well developed; hind trochanter + femur 450–600 µm long, hind tibia + tarsus 480–650 µm long, hind claw 35–45 µm long. Ratio of lengths of hind tibia + tarsus to hind trochanter + femur 0.96–1.08, ratio of lengths of hind tibia to tarsus 2.40–3.03, ratio of length of hind trochanter + femur to greatest width of femur 3.64–4.36. Tarsal digitules subequal, each 55–60 µm long. Claw digitules subequal, each 35–45 µm long. Translucent pores present on hind legs, totalling 49–70 on femur and tibia combined, but often absent on coxae (114–150 on coxa, femur and tibia combined with 32–49 on dorsal surface of each coxa on Californian specimens). Ostioles: both pairs present; each anterior ostiole poorly developed, with 22–32 trilocular pores and 4–7 setae; each posterior ostiole with 49–67 trilocular pores and 8–12 setae. Anal ring 120–198 µm wide, with 6 anal ring setae, each seta 170–262 µm long.

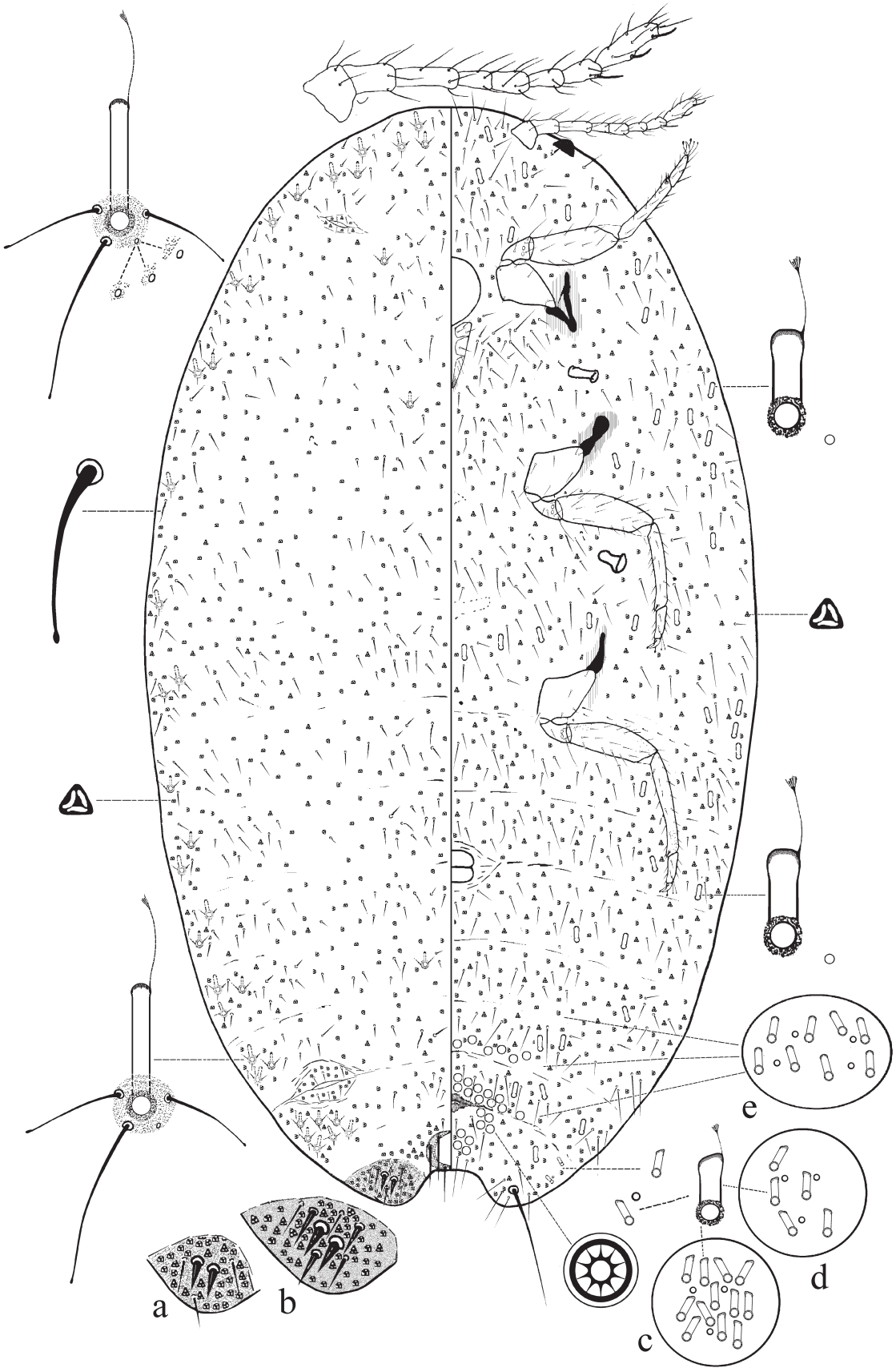

FIGURE 8. Adult female of *Ferrisia dasylirii* (Cockerell); main drawing based on specimens from *Dasylirion* in New Mexico and Arizona, USA; enlargements show the anal lobe cerarii as on specimens from (a) Imperial County, California, USA, and (b) from Arizona and New Mexico on *Dasylirion*; and clusters of small oral-collar tubular ducts as on specimens from (c) Aruba and Jamaica, (d) Imperial County, California, USA, and (e) Galapagos Islands, Ecuador.

Dorsum. Anal lobe cerarii each with 2 conical setae, 35–43 µm long, except some specimens on *Dasylirion* with an additional 2 or 3 robust setae, 20–36 µm long, slightly thinner than typical conical cerarian setae (Fig. 8b), with 45–67 trilocular pores and 3–8 auxiliary setae. Dorsal body setae slender, each 15–60 µm long. Trilocular pores each 4–5 µm in diameter. Enlarged tubular ducts totalling 55–114 on dorsum, each duct 30–40 µm long, 5.0–7.5 µm (generally 7.0–7.5 µm) wide at mid-length, rim of duct opening sclerotised, 10–13 µm wide, surrounded by a sclerotised circular area 15–35 µm wide, often enclosing 1 or 2 oval discoidal pores (touching outer margin of sclerotised area and sometimes projecting out from margin) and with 2–7 (generally 2 or 3) setae, each 22–48 µm long, usually either within rim (especially on abdomen) or on edge of rim (especially on head); ducts distributed marginally in clusters of 2–6 on head and thorax, on margins of all abdominal segments in groups of 2–4, but with 5–12 ducts on each side of abdominal segment VII, and also 2–7 medially to submarginally on head and thorax, 5–7 medially to submedially on abdominal segments.

Venter. Body setae slender, each 20–238 µm long, longest setae medially on head; apical setae of anal lobe 260–330 µm long. Multilocular disc pores present on posterior abdominal segments only: 1–19 pores on segment VI, 13–36 on segment VII, 13–22 on segments VIII + IX; each pore 7–10 µm in diameter. Trilocular pores each 3–4 µm in diameter. Minute discoidal pores each 2.5–3.5 µm in diameter, almost always associated with oral-collar tubular ducts, but never touching rim of ducts. Oral-collar tubular ducts on most of venter (excluding margins of posterior abdomen) each 12–15 µm long, 3–4 µm wide, totalling 23–81 (totalling 23–74 specimens on *Dasylirion*), distributed as follows: 12–32 on head and thorax, and on abdominal segments: 6–21 total on segments I–III; 2–7 on IV; 1–8 on V; 2–16 on VI; 5–15 on VII; none on VIII. Small oral-collar tubular ducts each 6.5–13.0 µm long, 2.5–4.0 µm wide, distributed as follows on margin of abdominal segments: 0–1 on each side of VI; 0–9 on each side of VII; 0–8 on each side of VIII (Fig. 8d).

Variation. Adult females of *F. dasylirii* display much variation in the presence or absence and abundance of translucent pores on the hind coxae. The type specimens from New Mexico lack translucent pores on the hind coxa, as do adult females from Aruba (ARU), Belize (BEL), Florida (FL) and Jamaica (JAM1 and JAM2). However females from two of the sequenced collections from Imperial County, California (CA2 and CA3), and one of the collections from *Dasylirion* in Arizona (AZ2) have fairly numerous translucent pores on the hind coxae. In a second sequenced Arizona collection (AZ3; also from *Dasylirion*), 12 of 16 females lack translucent pores on the coxae, three females have a few pores on just one coxa and a fourth female has pores on both coxae. The function of translucent pores is not known but it is possible that sex pheromones may be released from the pores (Williams 1985a).

Specimens from two populations collected from Jamaica show some differences from other specimens of *F. dasylirii* in having a higher number of small oral-collar tubular ducts marginally on abdominal segments VII and VIII (15–25 on each side of VII; 10–21 on each side of VIII) (Fig. 8c). Specimens from the Galapagos Islands (Ecuador), one adult female from Hawaii, and a few others from Florida and Brazil differ from all other females of *F. dasylirii* in possessing transverse clusters or short rows of small oral-collar tubular ducts submedially on abdominal segments IV–VII at each end of the row of multilocular pores of those segments, with 0–9 ducts on each side of IV; 1–8 on each side of V; 4–10 on each side of VI; 3–6 on each side of VII; and 0–5 on each side body on margin of VIII (Figure 8e). In addition, the minute discoidal pores on the medial to submedial derm of the ventral abdomen of the latter specimens are 2.5–4.5 µm in diameter and with a distinct rim (the pores in typical specimens of *F. dasylirii* are <2.5 µm in diameter and with an indistinct rim). The latter specimens may represent a distinct species; additional specimens and DNA data would help to establish the taxonomic status of this morphological form.

Ferrisia ecuadorensis Kaydan & Gullan sp. n.

(Fig. 9)

urn:lsid:zoobank.org:act:B18691C7-9133-4721-935F-0E51497DDFB9

Type material. Holotype: adult ♀, ex *Psidium guajava*, ECUADOR, 17. i. 1975, Waite & Wright, LA014175-CA (USNM).

ADULT FEMALE. Diagnosis. *Ferrisia ecuadorensis* can be diagnosed by the following combination of features: presence of large clusters of small oral-collar tubular ducts on ventral margins of all abdominal segments except abdominal segment I; ventral oral-collar tubular ducts generally with a minute discoidal pore touching rim; dorsal enlarged tubular ducts totalling 98 throughout dorsum, with 1 or 2 oval discoidal pores usually adjacent to rim of

each duct opening; number of multilocular disc-pores on venter of abdominal segments as follows: segment VI (3), VII (16), and VIII + IX (12); anal lobe cerarii each with 2 conical setae; both anterior and posterior pairs of ostioles present and well developed.

Ferrisia ecuadorensis is most similar to *F. milleri, F. kondoi* and *F. virgata* but the adult female is much more slender than the latter three species. The slide-mounted adult female of *F. ecuadorensis* can be distinguished readily from other species in the genus by having clusters of small oral-collar tubular ducts on the ventral margins of all abdominal segments except segment I (present only on segments VI–VII or VII–VIII in *F. kondoi* and on VII–VIII in *F. virgata*), and each duct is distinctively shaped with a slanted inner end and a long filamentous inner ductule. The adult female of *F. ecuadorensis* also differs from those of *F. virgata* in the position of the discoidal pores, which are usually always found adjacent to the rim of duct openings of both enlarged ducts and ventral oral-collar tubular ducts (discoidal pores never adjacent to rim of duct openings in *F. virgata*). *Ferrisia ecuadorensis* also is similar to *F. milleri* but it can be separated from this species by the absence of clusters of small oral-collar tubular on head and thorax (present in *F. milleri*).

Description of slide-mounted specimen (based on the holotype; Fig. 9). Body elongate oval, 2.37 mm long, 0.95 mm wide. Eye marginal, 65–70 µm wide. Antenna 8 segmented, 730–740 µm long; apical segment 130 µm long, 30–35 µm wide. Clypeolabral shield 185 µm long, 175 µm wide. Labium 200 µm long, 112.5 µm wide. Anterior spiracles 72–75 µm long, 40–45 µm wide across atrium; posterior spiracles 90 µm long, 60–80 µm wide across atrium. Circulus quadrate, 165 µm wide, divided by an intersegmental line. Legs well developed; hind trochanter + femur 550–540 µm long, hind tibia + tarsus 580 m long, hind claw 35 µm long. Ratio of lengths of hind tibia + tarsus to hind trochanter + femur 1.05, ratio of lengths of hind tibia to tarsus 3, ratio of length of hind trochanter + femur to greatest width of femur 4.8. Tarsal digitules subequal, each 60 µm long. Claw digitules subequal, each 45 µm long. Translucent pores present on hind coxa, femur and tibia, totalling about 35 on all segments combined, and scattered across dorsal surface of each hind coxa and near apex of femur and tibia. Ostioles: both pairs present; each anterior ostiole poorly developed, with 43 trilocular pores and 15 setae; each posterior ostiole with 45 trilocular pores and 15 setae. Anal ring 105 µm wide, with 6 anal ring setae, each seta 260–280 µm long.

Dorsum. Anal lobe cerarii each with 2 conical setae, each seta 43 µm long, with 42–44 trilocular pores and 3 or 4 auxiliary setae. Dorsal body setae slender, each 15–80 µm long. Trilocular pores each 4–5 µm in diameter. Enlarged tubular ducts totalling 98 on dorsum, each duct 28–33 µm long, 6–8 µm wide at mid-length, rim of duct opening 9–10 µm in diameter, sclerotised circular area around duct 15–25 µm in diameter, enclosing 1 or 2 oval discoidal pores (most pores touching rim of duct opening), and with 2–6 (usually 2 or 3) setae, each 25–30 µm long, usually either within rim of duct opening (especially on abdomen) or on edge of rim (especially on head); ducts distributed marginally in clusters of 1–6 on head and thorax, on margins of all abdominal segments in groups of 2 or 3, but with 8 or 9 ducts on each side of abdominal segment VII, 8 submedially on head and thorax, with 2 submedially on abdominal segment VI.

Venter. Body setae slender, each 15–180 µm long, longest setae medially on head; apical seta of anal lobe 305 µm long. Multilocular disc pores present on posterior abdominal segments only: 3 pores on segment VI, 16 on VII, and 12 on VIII + IX; each pore 8–10 µm in diameter. Trilocular pores each 4–5 µm in diameter. Minute discodial pores each 2.5 µm in diameter, almost always associated with oral-collar tubular ducts, with 1 or 2 pores touching rim of some oral-collar tubular ducts. Oral-collar tubular ducts on most of venter (excluding margins of posterior abdomen) each 10–11 µm long, 2.5 µm wide, totalling about 35, distributed as follows: 14 on head and thorax, and on abdominal segments: 7 on segments I–III, 2 on IV–VI, 8 on VII, and none on VIII. Small oral-collar tubular ducts each 6–8 µm long, 2.5–3.0 µm wide, inner end of duct distinctively slanted and with a long filamentous inner ductule, distributed on margins of abdominal segments as follows (number for one side of body specified): 32–36 on segment II, 36–39 on III, 32–35 on IV, 42 on V, 38–53 on VI, 47–54 on VII, 36–38 on VIII.

Etymology. This species is named for the country of the only known specimen.

Variation. The BME has a slide with two adult females that closely resemble the holotype of *F. ecuadorensis* except that they are less slender (2.30–2.57 mm long, 1.14–1.30 mm wide) and the marginal clusters of small ventral oral-collar tubular ducts are confined to the posterior abdominal segments, with each side of the body having a group of ducts as follows: 0–3 on V, 1–6 on VI, 1–18 on VII and 7–15 on VIII, and only an occasional small duct more anteriorly on the margin. These two specimens were collected on citrus at Limeira, near São Paulo, Brazil, 21 March 1958 by S. E. Flanders [S&R #1805-II-2]. It is impossible to establish the identity of the latter specimens until more material of *F. ecuadorensis* is collected to determine variation within this new species.

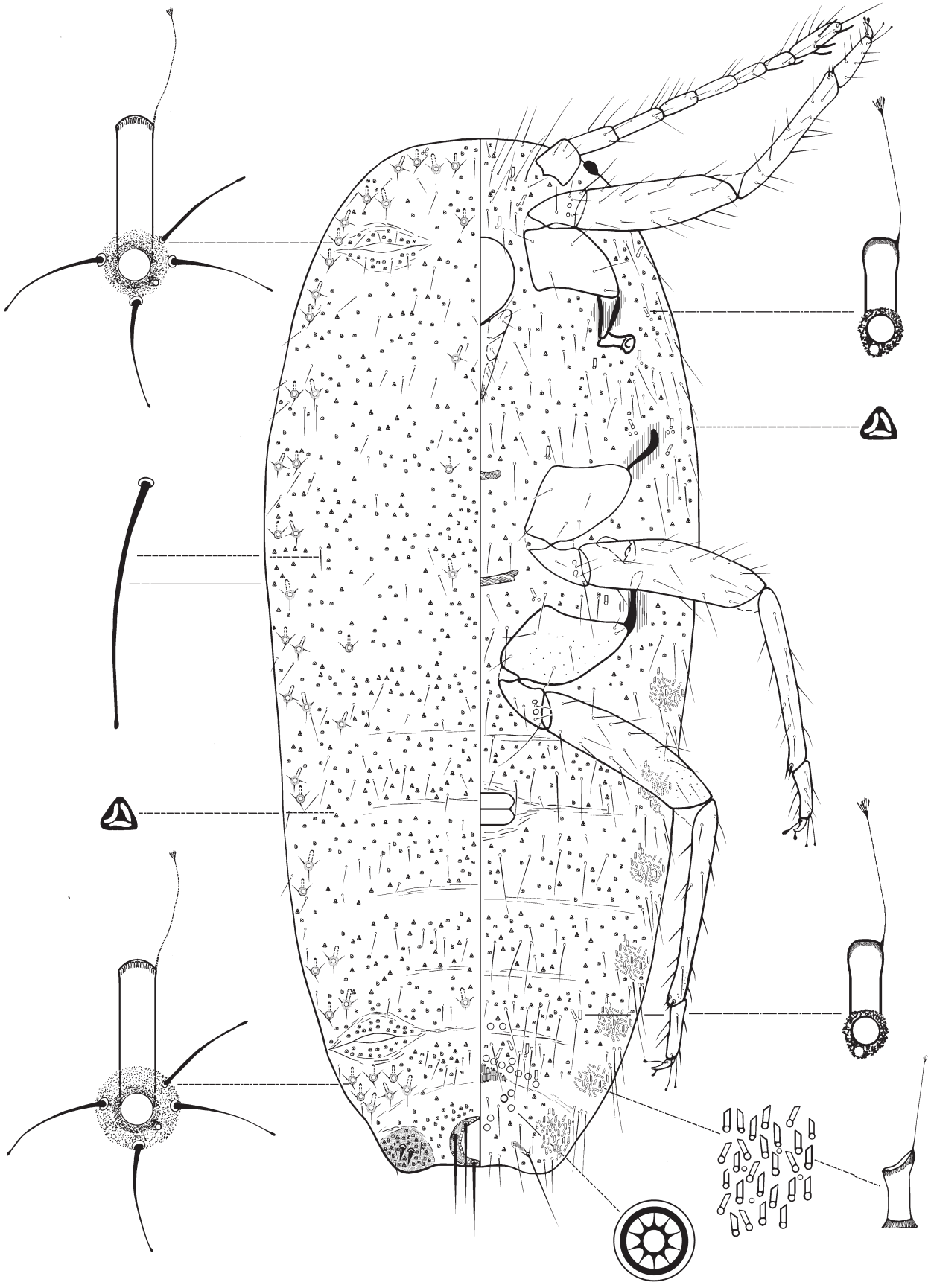

FIGURE 9. Adult female of *Ferrisia ecuadorensis* Kaydan & Gullan sp. n.

***Ferrisia gilli* Gullan**
(Figs 2B, C, 10)

Ferrisia gilli Gullan, in Gullan *et al*., 2003: 728.

This species was described from Alabama, California, Georgia and Louisiana, U.S.A., from pistacio, other trees and grass (Gullan *et al.* 2003). The adult female and all female nymphal instars were described and illustrated. In California, this species is commonly called Gill's mealybug, as it was named to honour Raymond Gill. Infestations of *F. gilli* are a problem in orchards and vineyards in California (Daane *et al.* 2008, 2012; Haviland *et al.* 2006, 2012) and slide-mounted specimens from some infestations are deposited in the BME and CSCA. In particular, there are recent CSCA records of *F. gilli* from vineyards in El Dorado, Fresno, Lake, Lincoln and Placer counties, California, as well as 2011 FSCA records from vineyards in Winchester, Virginia.

The status of *F. gilli* as a species distinct from *F. quaintancii* requires confirmation even though the adult females differ substantially in morphology. For example, the adult female of *F. gilli* is distinguished readily from that of *F. quaintancii* by the presence of more than 90 enlarged tubular ducts on the dorsum, compared with 0–2 ducts on *F. quaintancii*. However seven samples (six from California and one from Alabama) of *F. gilli* that were sequenced for the study of Gullan *et al*. (2010) formed a group with a single immature specimen of putative *F. quaintancii* (from the roots of *Rhus copallina* in Florida) in all data partitions and analyses. We continue to treat *F. gilli* and *F. quaintancii* as separate species pending further collection of specimens of *F. quaintancii* for use in DNA investigation. Refer to the discussion of this taxonomic problem and a more detailed comparison of *F. gilli* and *F. quaintancii* under the text for the latter species.

It seems clear that there is environmentally based variation in the number of small oral-collar tubular ducts per marginal cluster as well as the number of marginal clusters of these ducts on adult females of *F. gilli* (Gullan *et al.* 2010). This variation may be induced by temperature of development of the mealybug and/or by host-plant effects. For example, adult females of *F. gilli* collected from *Laurus nobilis* in Davis, California, during June 2003 had fewer small tubular ducts than females of the next generation collected from the same individual tree in August 2003, suggesting that temperature may affect expression of these ducts. Furthermore, specimens with many small tubular ducts (in segmental clusters around the entire body) that were collected from *Magnolia* in Davis, California, were almost identical genetically to other Californian specimens of *F. gilli* that had few small tubular ducts and were collected from host plants other than *Magnolia* (Fig. 3; see Table 1 of Gullan *et al*. (2010) for collection data). Many adult female specimens from the eastern and southeastern United States that were collected from *Magnolia* and certain other tree species have clusters of small oral-collar tubular ducts segmentally around the body with numerous ducts per cluster (usually more ducts per cluster than on females from *Magnolia* in Davis). Gullan *et al*. (2003: 738) discussed specimens that had clusters of two to many oral-collar ducts marginally on most segments and with a cluster always near the base of each antenna, but they tentatively attributed these differences to an undescribed species that was closely related to *F. gilli.* Fresh material of this alternative phenotype was not available to Gullan *et al*. (2003) for DNA analysis, and thus they excluded those specimens from the description of *F. gilli.* Gullan *et al.* (2010) obtained DNA sequences from females of the alternative phenotype (from *Magnolia grandiflora* in Davis) and showed that these specimens (CA 6 and CA 7 in Fig. 3) were part of the *F. gilli* clade. Below we describe and illustrate this alternative phenotype, which we call the *Magnolia* form of the adult female of *F. gilli* (Fig. 10).

Material examined (*Magnolia* form): UNITED STATES OF AMERICA: 6 adult ♀♀ (6 slides), ex *Magnolia grandiflora*, Alabama, Dale Co., Ft. Rucker, 18.vii.1978, T.B. Hagler, Al-084-78, (AUCC); 1 adult ♀, ex *Cercis canadensis*, Alabama, Lee Co., Chewacla State Park, 17.iv.1976, B.J. Muse, Al-720-76 (AUCC); 1 adult ♀, ex funnel trap in tupelo swamp, Alabama, Baldwin Co., 1.5 mi. SW Stockton, 10.iv.1975, J.D. Harper et al., Al-078-79 (AUCC); 1 adult ♀, ex *Cornus florida*, Alabama, Randolph Co., Wedowee, 20.v.1977, M.L. Williams, Al-94-77 (AUCC); 1 adult ♀, ex *Carya tomentosa*, Alabama, Randolph Co., 25.vii.1977, C.H. Ray Jr, I. Daniels & K. Manuel, Al-184-77 (AUCC); 3 adult (3 slides), ex *M. grandiflora*, Alabama, Tuscaloosa Co., 9.v.1974, Pigott, AL-30-74 (AUCC); 11 adult ♀♀ (11 slides including DNA voucher FBK035), ex trunk of *Laurus nobilis*, California, Yolo Co., Davis, Downtown, on Third St near G Street, 3.vi.2003 and 1.viii.2003, T. Kondo (BME); 7 adult ♀♀ (7 slides including DNA vouchers FBK046 & NH162), ex leaves and fruit of *Magnolia grandiflora*, California, Davis, corner of Russell Blvd and La Rue Road, 10.x.2006 by M.B. Kaydan, 11.ix.2008 by P.J. Gullan & A.R. Van

Dam (BME); 4 adult ♀♀ (2 slides) ex leaves of *Zamia* sp.?, Florida, Coral Gables (U of M), 11.i.1966, S. Nakahara (USNM); 1 adult ♀, ex *Ceratiola ericoides*, Florida, Port Saint Lucie, 21.xii.1983, K. Hibbard (FSCA); 1 adult ♀, ex *Magnolia*, Georgia, Early Co., 23.vii.1969, H.H. Tippins, HHT-113-69 (AUCC); 3 adult ♀♀ (1 slide) ex *Magnolia* sp., Louisiana, New Orleans, 08.iv.1945, Rau coll. Sp. Surv. 25250 (USNM); 1 adult ♀, ex *Robinia pseudoacacia*, Virginia, Blacksburg, VPI campus, 19.v.1969, R.C. Brachman, Va 770 (USNM); 2 adult ♀♀ (1 slide), ex *Liquidambar styraciflua*, Virginia, Montgomery Co, Blacksburg, VPI campus, Plot 65 II F, 052269, 22.v.1969, D.K Puller (USNM); 1 adult ♀, ex sycamore (*Platanus occidentalis*), Virginia, Charlottesville, 09.v.1946, D.W. Clancy (USNM); 2 adult ♀♀ (1 slide), ex *Magnolia*, Virginia, Richmond, 15.viii.1963, M. Kosztarab and D.V., Va. 27E (USNM); 7 adult ♀♀ (3 slides), ex *Magnolia grandiflora*, Virginia, Richmond, collected by M. Kosztarab as 2nd & 3rd instar nymphs, raised to adulthood on potatoes in lab. N.Y. (USNM).

ADULT FEMALE. Diagnosis (based on both *Magnolia* and type forms). *Ferrisia gilli* can be diagnosed by having the following combination of features: absence of anterior ostioles; ventral oral-collar tubular ducts of more than one size; clusters of small oral-collar tubular ducts on ventral margins of at least the posterior abdominal segments, sometimes on all body segments; ventral oral-collar tubular ducts generally associated with 1 or 2 minute discoidal pores around duct rim (never touching rim), each pore 2.5–3.5 µm in diameter; dorsal enlarged tubular ducts totalling 90–144 on dorsum, with 1 or 2 oval discoidal pores usually associated with rim of each duct opening; number of multilocular disc pores on venter of abdominal segments as follows: 5–20 on segment VII, and 6–23 on segment VIII + IX; anterior pair of ostioles absent, posterior pairs well developed.

The morphological form of *F. gilli* found on *Magnolia* and several other tree hosts is similar to the type form of *F. gilli*, but differs by having many more marginal clusters of oral-collar tubular ducts (clusters confined to posterior abdomen in type form) and a high number of small oral-collar tubular ducts in the marginal duct clusters of body segments excluding abdominal segment VIII (3–29, often more than 10, per cluster in the *Magnolia* form and 0–7, mostly 3–5, per cluster in the type form). All adult females of *F. gilli* lack anterior ostioles, as do adult females of *F. claviseta*, *F. quaintancii* and *F. setosa*, but in the first two of the latter three species, the dorsal enlarged tubular ducts usually number fewer than 12, whereas *F. gilli* usually has more than 100 enlarged ducts. Furthermore *F. setosa* has more than 2 cerarian setae on each cerarius and more than 6 anal ring setae, whereas *F. gilli* has 2 conical setae on each cerarius and 6 anal ring setae. The *Magnolia* form of *F. gilli* is similar to *F. milleri* by having small oral-collar tubular duct clusters on all body segments, but can be separated from *F. milleri* by the absence of anterior ostioles and absence of multilocular pores on abdominal segment VI (both features present in *F. milleri*).

Description of slide-mounted specimens of *Magnolia* form (based on 30 females; Fig. 10) [See Gullan *et al*. (2003) for description of type form of *F. gilli*]. Body elongate oval, 2.94–5.36 mm long, 1.22–2.44 mm wide. Eye marginal, 55–85 µm wide. Antenna 8 segmented, 550–780 µm long; apical segment 122–148 µm long, 30–45 µm wide. Clypeolabral shield 190–250 µm long, 110–145 µm wide. Labium 210–250 µm long, 170–250 µm wide. Anterior spiracles 70–115 µm long, 40–68 µm wide across atrium; posterior spiracles 82–120 µm long, 55–80 µm wide across atrium. Circulus quadrate, 125–245 µm wide, divided by an intersegmental line. Legs well developed; hind trochanter + femur 425–560 µm long, hind tibia + tarsus 435–580 m long, hind claw 35–45 µm long. Ratio of lengths of hind tibia + tarsus to hind trochanter + femur 0.96–1.05, ratio of lengths of hind tibia to tarsus 2.37–2.82, ratio of length of hind trochanter + femur to greatest width of femur 3.88–4.45. Tarsal digitules subequal, each 62–70 µm long. Claw digitules subequal, each 40–45 µm long. Translucent pores present on hind legs, totalling 37–110 on coxa, femur and tibia combined. Ostioles: only posterior pair present; each ostiole with 41–56 trilocular pores and 8–10 setae. Anal ring 125–160 µm wide, with 6 anal ring setae, each seta 220–265 µm long.

Dorsum. Anal lobe cerarii each with 2 conical setae, each seta 35–45 µm long, with 31–44 trilocular pores and 4–6 bluntly-tipped auxiliary setae. Dorsal body setae slender, each 15–70 µm long. Trilocular pores each 4–5 µm in diameter. Enlarged tubular ducts totalling 90–144 on dorsum, each duct 33–40 µm long, 6–8 µm wide at mid-length, rim of duct opening 10–15 µm in diameter, surrounded by a sclerotised circular area 20–35 µm in diameter, enclosing 1 or 2 oval discoidal pores (each pore usually adjacent to rim of duct opening) and with 2–7 (generally 2 or 3) setae, each 17–43 µm long, usually either within rim of duct opening (especially on abdomen) or on edge of rim (especially on head); ducts distributed marginally in clusters of 1–4 on head and thorax, on margins of all abdominal segments in groups of 2–5, but with 6–9 ducts on each side of abdominal segment VII, and also 10–16 medially to submarginally on head and thorax, and 8–14 medially to submarginally on abdominal segments.

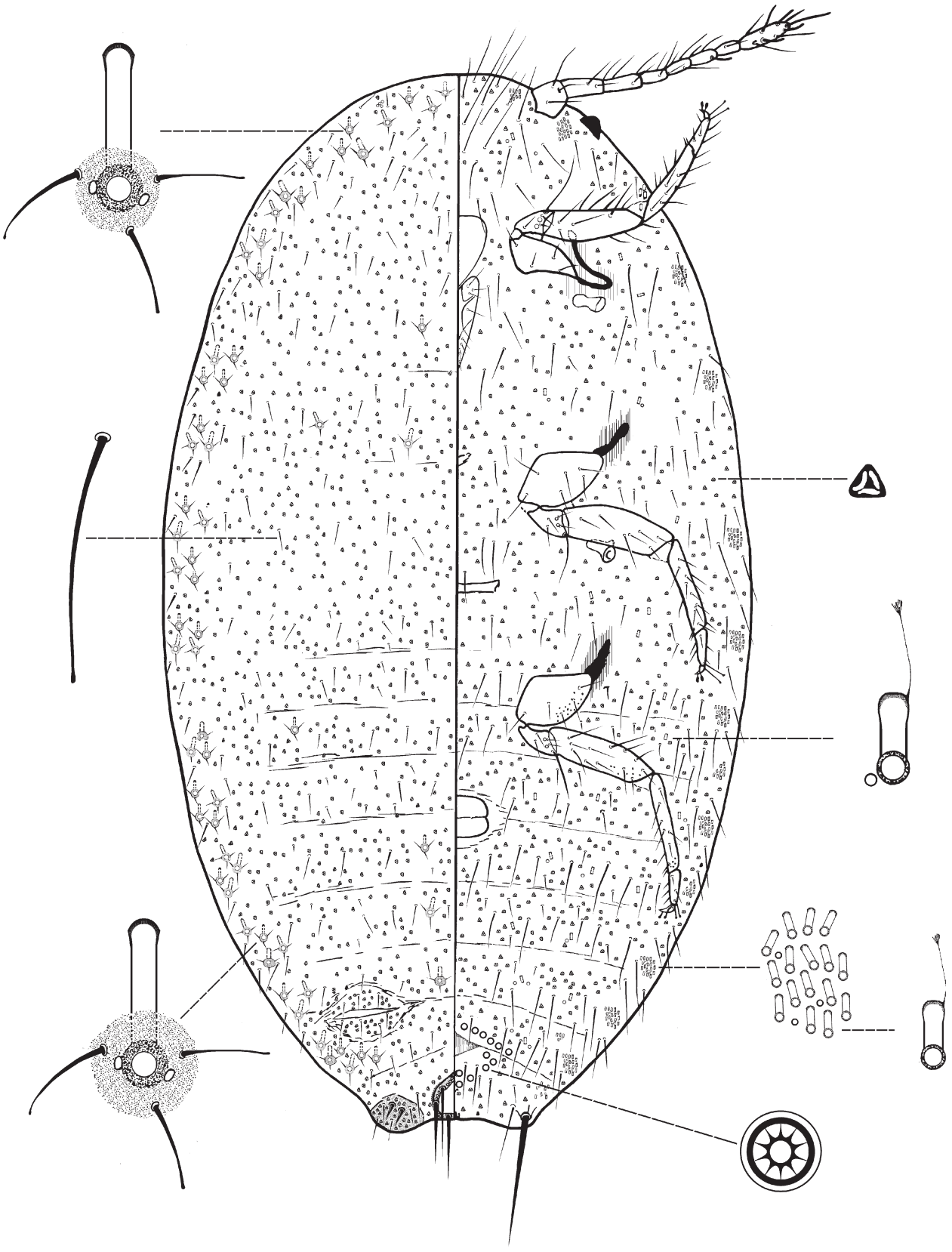

FIGURE 10. Adult female of *Ferrisia gilli* Gullan from *Magnolia grandiflora*; note the segmental marginal clusters of small ventral oral-collar tubular ducts.

Venter. Body setae slender, each 15–225 µm long, longest setae medially on head; apical seta of anal lobe 275–343 µm long. Multilocular disc pores present on posterior abdominal segments only: 0 or 1 (generally none) pores on segment VI, 9–15 on segment VII, 6–16 on segments VIII + IX; each pore 7.5–10.0 µm in diameter. Trilocular pores each 4–5 µm in diameter. Minute discodial pores each 2.5–3.0 µm in diameter, almost always associated with oral-collar tubular ducts, with 1 or 2 pores very close to (but never touching) rim of most oral-collar tubular ducts, with 1 or 2 pores present among the small oral-collar tubular ducts clusters. Oral-collar tubular ducts on most of venter (excluding margins of posterior abdomen) each 8–13 µm long, 2.5–4.0 µm wide, totalling 74–88, distributed as follows: 23–30 on head and thorax, and on abdominal segments: 12–16 total on segments I–III, 2–5 on IV; 3–8 on V; 3–6 on VI; 2–4 on VII, and none on VIII. Small oral-collar tubular ducts each 6.0–8.0 µm long, 2.5 µm wide, distributed in up to 15 marginal clusters on each side of body as follows: 6–29 on head at base of antennae (these often in 2 clusters), 4–16 per cluster on thoracic segments, 6–22 on abdominal segment I; 5–16 on II; 5–15 on III; 7–16 on IV; 3–29 on V; 3–26 on VI; 8–27 on VII; 0–12 on VIII.

***Ferrisia kondoi* Kaydan & Gullan sp. n.**
(Figs 2D, E, 11)
urn:lsid:zoobank.org:act:C92ABA3B-0052-4913-B288-7DF17A982621

Type material. Holotype: adult ♀, ex leaf of *Ficus* sp. (Moraceae), COLOMBIA, Valle del Cauca, Cali, 27.xii.2005, T. Kondo, UCDC type # 1790 (BME). **Paratypes**: 3 adult ♀♀ (3 slides), same data as holotype (2 slides BME including DNA voucher FBK028, 1 slide USNM); 6 adult ♀♀, 2 third-instar ♀♀ (8 slides), ex *Mangifera indica*, COLOMBIA, Cali, Valle del Cauca, 5.i.2002, T. Kondo (BME); 1 adult ♀, ex leaf of Palmae [=Arecaceae], COLOMBIA, Valle del Cauca, Cali, 20.i.2008, T. Kondo (BME); 1 third-instar ♀ (very damaged, DNA voucher FBK030), ex *Codiaeum variegatum*, COLOMBIA, Valle, Palmira, 15.vii.2003, T. Kondo (BME); 11 adult ♀♀ including one pharate in third-instar cuticle (11 slides), ex leaves of *Pithecellobium dulce*, COLOMBIA, Valle del Cauca, Palmira, Cali International Airport, 03°33'N, 76°23'W, 1017 m, 2.x.2008, T. Kondo (2 slides ANIC, 3 BME, 1 CSCA, 1 IMLA, 1 USNM, 3 UNCB); 1 adult ♀ (DNA voucher FBK027), ex *Psidium guineense* (Brazilian guava), PERU, Iquitos, 20. vi. 2002, S. Kawai (BME).

Other material examined: 5 adult ♀♀, ex *Codiaeum variegatum*, BRAZIL, #95, 19.ix.1997, Ana Lucia B. G. Peronti, 9801139 (USNM); 2 adult ♀♀ (2 slides), ex branch of *Inga* sp., COLOMBIA, Cundinamarca, Fusagasugá, x.1977, I. Zenner (USNM); 4 adult ♀♀ (2 slides), ex mango, Espina L.T., 28.ii.1972, T. Aldana, 72-9827 (USNM); 3 adult ♀♀ (1 slide), ex coffee, COLOMBIA, Las Palmas (Ant.), 5.viii.1955, A. Saldarriaga (USNM); 1 adult ♀, ex *Coffea arabica*, COLOMBIA, Leticia, 27.ix.1971, H. Martin, 71-20444 #116 (USNM); 4 adult ♀♀ (3 slides), ex *Psidium* sp., COLOMBIA, Cundinamarca, Mesitas del Colegio, 5.x.1977, L. Nunez, 77-047 (USNM); 5 adult ♀♀ (3 slides), ex *Annona chirimoia* [sic], COLOMBIA, Villa Garzón (Put.), 30.vi.1971, F. Mosquero & H. Martin, 71-13465 (USNM); 3 adult ♀♀ (1 slide), ex cacao, COSTA RICA, Limon, Bristol, 20.i.1957, F. Lara, 57-0401, 57-0402 (USNM); 1 adult ♀, 1 third-instar ♀, 2 second-instar nymphs (1 slide), ex café, COSTA RICA, Turrialba, 15.viii.1952, C. H. Batchelder #49 (USNM); 1 adult ♀, ex *Syzygium malaccense* fruit, GUYANA, 22.x.1981, E. P. Bulram (USNM); 1 adult ♀, ex *Codiaeum* sp. leaf, HONDURAS, intercepted Miami #1814, 28.vii.1970, coll. F. D. Matthews (USNM); 1 adult ♀, ex *Croton* sp. (lvs., petioles, stems), MEXICO, Yucatan, Merida, 6.vii.1960, S.W. Brown and W.A. Nelson-Rees (BME); 2 adult ♀♀ (1 slide), ex *Zingiber* sp., cut flower, MEXICO, 7.ix.1984, R. Elliott, intercepted Dallas/Ft Worth 003330 (USNM); 1 adult ♀, ex *Fraxinus* sp. (leaves), MEXICO, Nuevo León, Monterrey, 13.vi.1960, S.W. Brown and W. A. Nelson-Rees, M.III-2 (BME); 1 adult ♀ (1 slide), ex *Gardenia* sp., MEXICO, intercepted at Brownsville, USA, 3.ii.1940, C. L. Parnell, Brownsville 37953 (USNM); 1 adult ♀ (1 slide), ex *Echeveria* sp., MEXICO, intercepted at Laredo, USA, 7.iv.1944, E. P. Reagen, Laredo 33539 (USNM).

Other material of doubtful identity (slides poor or females not totally typical of *F. kondoi*): 4 adult ♀♀ (4 slides), ex *Codiaeum variegatum*, BRAZIL, Jaboticabal, 25.x.1989, H.W. Browning (E97-1336 (FSCA); 1 adult ♀, ex *Gardenia* sp., MEXICO, intercepted at Brownsville, USA, 13.xii.1941, Williamson coll., Brownsville 49704 (USNM); 2 adult ♀♀ (1 slide), ex *Croton*, MEXICO, Veracruz, Córdoba, 12.v.1952, R. MacGregor, RMG-P-200 (BME); 1 adult ♀, ex guava, MEXICO, Puerto Mexico, Ferris No. 233 (BME); 5 adult ♀♀ (1 slide), ex *Mangifera indica*, MEXICO, Tolome, Carretera Tolome to Hatilo km 1, Municipio paso de Ovejas, 5.vi.1999, #25, G. H. Villanueva (USNM); 1 adult ♀, ex *Musa paradisiaca*, MEXICO [incomplete data] (FSCA); 1 adult ♀, ex *Codiaeum* sp., VENEZUELA, Barquisimeto, 2.v.1991, F. Bennett, 1005 (FSCA).

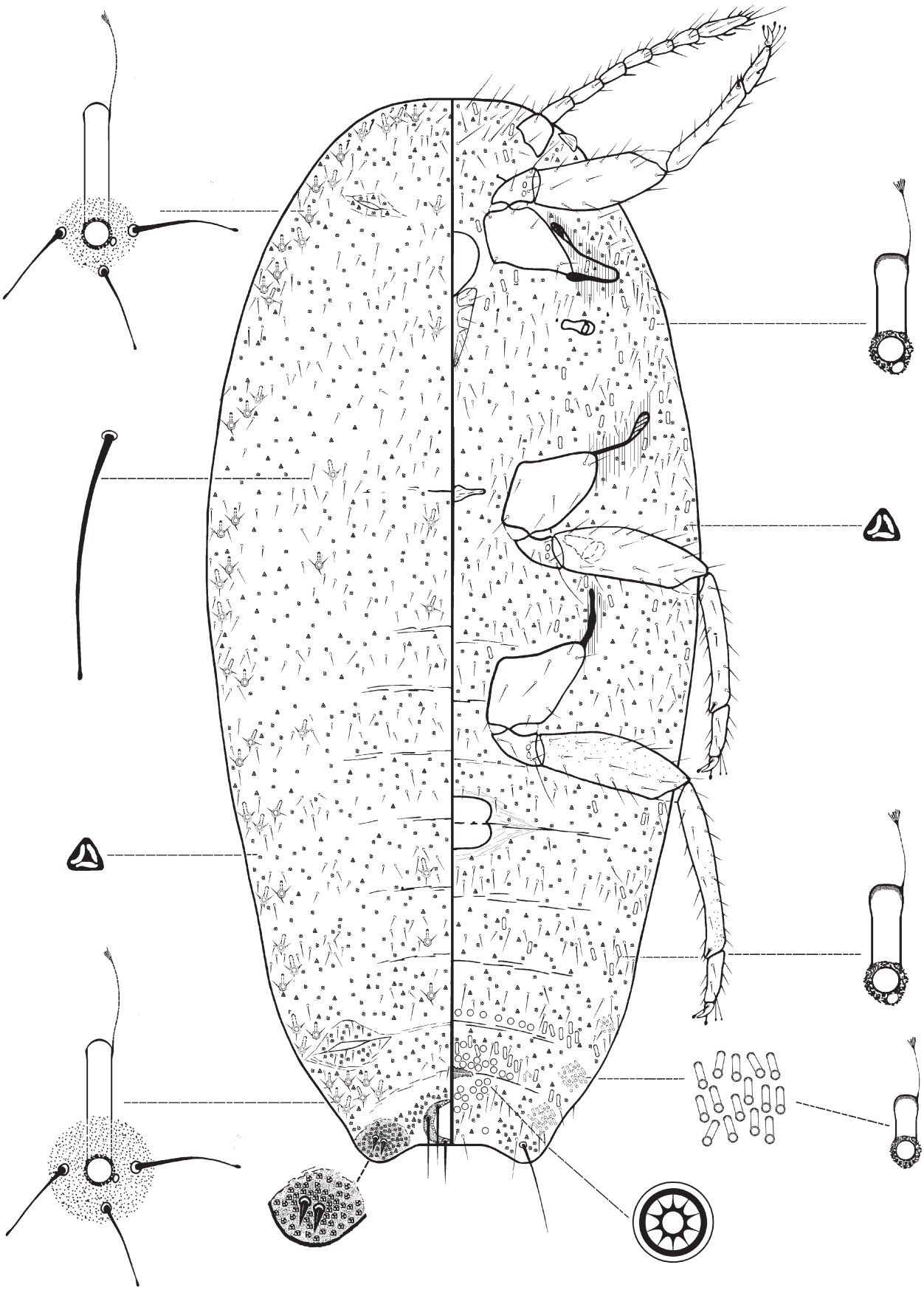

FIGURE 11. Adult female of *Ferrisia kondoi* Kaydan & Gullan sp. n.

ADULT FEMALE. Diagnosis. *Ferrisia kondoi* can be diagnosed by the following combination of features: presence of clusters of small oral-collar tubular ducts on ventral margins of last 2–3 abdominal segments; ventral oral-collar tubular ducts generally with a minute discoidal pore touching rim of duct opening; dorsal enlarged tubular ducts totalling 91–128 throughout dorsum, with 1 or 2 oval discoidal pores usually adjacent to rim of each duct opening; number of multilocular disc-pores on venter of abdominal segments as follows: segment VI (8–22), VII (22–38), and VIII + IX (20–37); anal lobe cerarii each with 2 conical setae; both pairs of ostioles present and pairs well developed; no translucent pores on hind coxa.

Ferrisia kondoi is most similar to *F. williamsi* and *F. cristinae*, but can be distinguished by lacking translucent pores on the hind coxa (present on coxa in other two species), having ≥60 trilocular pores on each anal lobe (≤50 pores on each lobe of other two species), and having small oral-collar tubular ducts usually in tight segmental clusters on ventral margins of posterior abdominal segments with 0–7 on each side of segment VI, 6–25 on each side of VII, 8–21 on each side of VIII (these ducts either not forming tight clusters or in small clusters with each side of each segment usually with ≤6 ducts in other two species). *F. kondoi* can be distinguished from *F. virgata* by usually having clusters of small oral-collar tubular ducts on the ventral margins of the last 3 abdominal segments (present only on VII and VIII in *F. virgata*), and by having 1 or 2 discoidal pores adjacent to the duct opening for both enlarged ducts and ventral oral-collar tubular ducts (discoidal pores never adjacent to duct openings in *F. virgata*). *F. kondoi* can be separated from *F. milleri* and *F. ecuadorensis* by the absence of small clusters of oral-collar tubular ducts on the head, thorax and anterior abdominal segments, and the absence of translucent pores on the coxa. *F. kondoi* can be distinguished readily from *F. uzinuri* by having clusters of small oral-collar tubular ducts on the ventral margins of the posterior abdominal segments (absent in *F. uzinuri*), and by having ventral oral-collar tubular ducts of more than one size and generally longer dorsal setae (15–70 µm in *F. kondoi*, and 12–38 µm long in *F. uzinuri*).

This species is common in Central and South America on a diversity of edible and ornamental plants, and often is intercepted by quarantine authorities at ports in the USA. We have restricted the type specimens and description to several recent collections from Colombia and one from Peru because DNA data are available for most of these collections.

Description of slide-mounted specimens (based on type material only; Fig. 11)**.** Body 2.54–5.4 mm long (holotype 4.0 mm), 1.14–2.84 mm wide (holotype 2.05 mm). Eye marginal, 65–80 µm wide. Antenna 8 segmented, 630–740 µm long; apical segment 115–130 µm long, 32–40 µm wide. Clypeolabral shield 175–210 µm long, 180–210 µm wide. Labium 200–220 µm long, 140–160 µm wide. Anterior spiracles 72–105 µm long, 40–63 µm wide across atrium; posterior spiracles 95–125 µm long, 65–93 µm wide across atrium. Circulus quadrate, 180–260 µm wide, divided by an intersegmental line. Legs well developed; hind trochanter + femur 510–680 µm long, hind tibia + tarsus 520–680 µm long, hind claw 42–45 µm long. Ratio of lengths of hind tibia + tarsus to hind trochanter + femur 0.98–1.05, ratio of lengths of hind tibia to tarsus 2.73–3.58, ratio of length of hind trochanter + femur to greatest width of femur 4.74–5.52. Tarsal digitules subequal, each 62–65 µm long. Claw digitules subequal, each 42–45 µm long. Translucent pores absent on coxa, totalling 25–67 on femur and tibia combined. Ostioles: both pairs present; each anterior ostiole poorly developed, with 40–43 trilocular pores and 6–10 setae; each posterior ostiole with 42–51 trilocular pores and 9–15 setae. Anal ring 135–160 µm wide, with 6 anal ring setae, each seta 260–305 µm long.

Dorsum. Anal lobe cerarii each with 2 conical setae, 42–45 µm long, with ≥60 trilocular pores and 4 or 5 bluntly-tipped auxiliary setae. Dorsal body setae slender, each 15–70 µm long. Trilocular pores each 4–5 µm in diameter. Enlarged tubular ducts totalling 91–128 on dorsum, each duct 32–38 µm long, 6–8 µm wide at mid-length, rim of duct opening sclerotised, 10–13 µm wide, surrounded by a sclerotised circular area 25–40 µm wide, enclosing 1 or 2 oval discoidal pores (each generally adjacent to duct opening) and with 2–6 (generally 2 or 3) setae, each 20–38 µm long, usually adjacent to duct rim within sclerotised area (especially on abdomen) or on edge of circular sclerotised area (especially on head); ducts distributed marginally in clusters of 2–6 on head and thorax, on margins of all abdominal segments in groups of 3–5, but with 8–9 ducts on each side of abdominal segment VII, and also 5–8 medially to submarginally on head and thorax, 3–5 medially on abdominal segments.

Venter. Body setae slender, each 15–210 µm long, longest setae medially on head; apical seta of anal lobe 275–340 µm long. Multilocular disc pores present on posterior abdominal segments only: 8–22 pores on segment VI, 22–38 on segment VII, 20–37 on segments VIII + IX; each pore 7–10 µm in diameter. Trilocular pores each 3–4 µm in diameter. Minute discodial pores each 2.0–2.5 µm in diameter, almost always associated with oral-collar tubular ducts, with 1 or 2 pores touching rim of most oral-collar tubular ducts. Oral-collar tubular ducts on most of

venter (excluding margins of posterior abdomen) each 10–15 µm long, 2.5–3.5 µm wide, totalling 87–113, distributed as follows: 20–26 on head and thorax, and abdominal segments: 6–10 total on segments I–III; 4–8 on each of IV & V; 10–18 on VI; 12–21 on VII; 0–2 (mostly none) on VIII. Small oral-collar tubular ducts each 6.0–7.5 µm long, 3–4 µm wide, distributed on margins of abdominal segments as follows: 0–7 on each side of segment VI; 6–25 on each side of VII; 8–21 on each side of VIII.

Etymology. This species is named in honour of Dr Takumasa Kondo, who collected most of the type material and provided photographs (Fig. 2D, E) and generous assistance with this project. Kondo *et al.* (2008) listed a large number of specimens of this species from Colombia, and Kondo (2010) provided a photograph and brief description of the adult female from mango in Colombia, referring to it as *Ferrisia* sp.

Ferrisia malvastra (McDaniel)

(Fig. 12)

Heliococcus malvastrus McDaniel, 1962: 323.
Heliococcus malvastrus; McKenzie, 1967: 181. Incorrect synonymy with *D. virgatus*.
Ferrisia consobrina Williams & Watson, 1988: 77. Synonymy by Williams, 1996: 5.
Ferrisia malvastra; Williams, 1996: 5. Revived status and change of combination.

Type material examined. Holotype: adult ♀, 2 labels: "Holotype ♀ / UC Davis Type#1502 / Heliococcus / malvastrus / B. McDANiel / BrowNsville Texas / JuNe 16, 1961 / Ex. Malvastrum / sp. / M.F. Schuster coll. / B. McDANiel Det." and "U.C. Davis / TYPE / 1502" (BME). **Paratype:** adult ♀, labels: "Heliococcus / malvastrus / McDANiel / Paratype ♀" [the word "Paratype" is in red ink] and "BROWNSViLLe Tex. / JUNe 16, 1961 / Ex. Malvastrum / sp. M.F. Schuster coll. / B. McDANiel Det" (USNM) [the handwriting on the labels is an odd mix of upper and lower case letters].

This widespread and polyphagous species was first described from *Malvastrum* (Malvaceae) from Texas, U.S.A., but was confused with *F. virgata* for many years. Nur (1977) recognised that specimens of this species were distinct from *F. virgata*, although at that time this species was referred to as the parthenogenetic form of *F. virgata*. Subsequently Williams (1985a) described this species as the "uniparental strain" of *F. virgata*, based partly on Nur's research, and later named it *F. consobrina* based on specimens from Queensland, Australia (Williams & Watson 1988). Subsequently, Williams (1996) discovered the synonymy of *F. consobrina* and *H. malvastrus,* revived the latter from synonymy with *Dactylopius virgatus* and transferred it to *Ferrisia* as *F. malvastra*. There is a good illustration of the adult female in Williams (1985a, 2004), Williams & Watson (1988) and Williams & Granara de Willink (1992), which has been redrawn and modified here (Fig. 12).

We examined the two type specimens (listed above) as well as numerous specimens (from ANIC, AUCC, BME, CSCA, FSCA and USNM) of *F. malvastra* from many countries and several states of the USA (Arizona, California, Florida and Texas), and from a diversity of host plants. The species appears to be found most often on succulent and herbaceous plants, including shrubs, often in the families Asteraceae, Cactaceae, Euphorbiaceae, Malvaceae, Solanaceae and Verbenaceae. Ben-Dov (2005) recorded *F. malvastra* from 18 plant families in Israel, where it is considered to be an introduced species. It has been distributed widely and is found in all biogeographic regions (Ben-Dov 2012). Williams & Granara de Willink (1992) predicted that *F. malvastra* may be found more widely in Central and South America. In addition to the Neotropical countries listed by Williams & Granara de Willink (1992), *F. malvastra* has been recorded from Brazil on the roots of a weedy asteraceous plant, *Bidens pilosa* (Culik *et al*. 2006). It is sometimes called the malvastrum mealybug (e.g., Ben-Dov 2005).

The adult female of *F. malvastra* has a broadly oval body shape, both pairs of ostioles well developed, multilocular pores only immediately anterior and posterior to the vulva, and the dorsal enlarged tubular ducts often have their associated setae situated on the edge of the small sclerotised area surrounding each duct. Most importantly, the dorsal enlarged tubular ducts on adult females of this species are noticeably more slender than in other species (except for *F. terani*), especially the ducts on the head which are ≤4.5 µm in diameter at mid length in *F. malvastra*, whereas these ducts in other species are typically ≥5.0 µm in diameter at mid-length. However if adult females of *F. malvastra* are over-cleared in KOH, the ducts collapse and increase in apparent width. Also the size of the sclerotised area around the opening of these enlarged tubular ducts varies depending on the maturity of the specimen, being larger in old females. This species is compared with the closely related *F. terani* under the entry for the latter species.

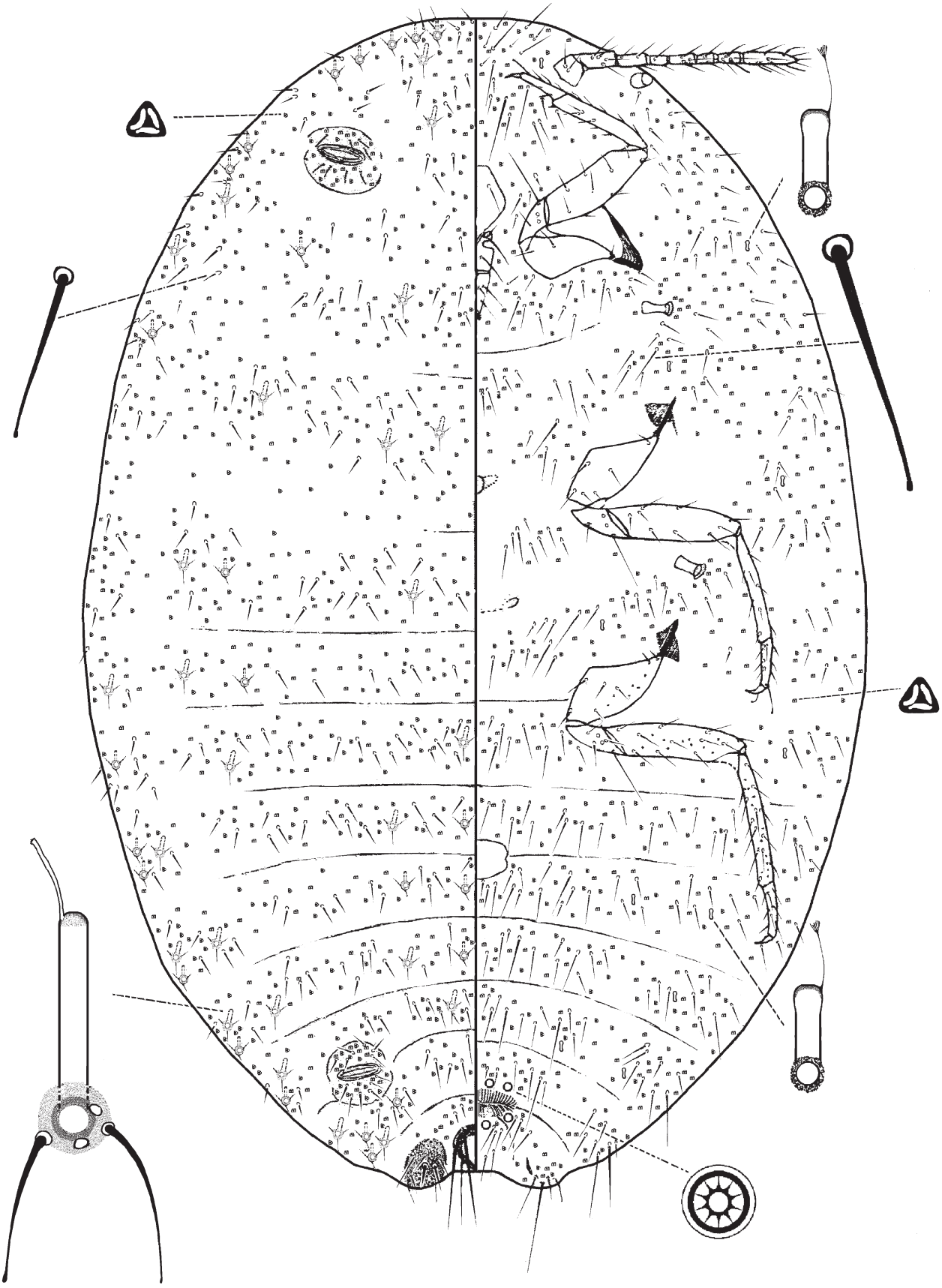

FIGURE 12. Adult female of *Ferrisia malvastra* (McDaniel). Modified from figure 65 in Williams (1985a) with permission of the author.

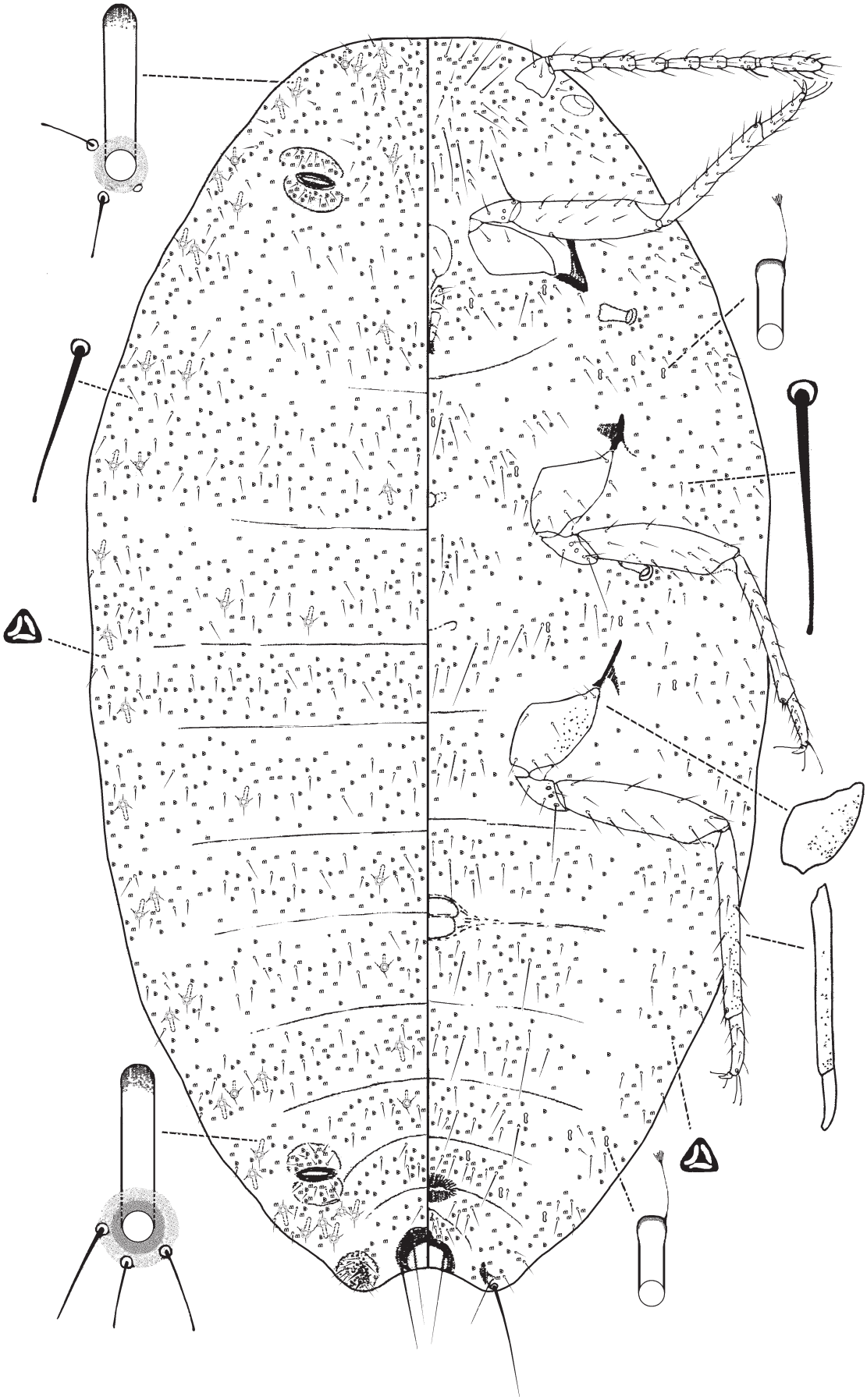

FIGURE 13. Adult female of *Ferrisia meridionalis* Williams. Modified from figure 67 (drawn by D.J. Williams) in Williams & Granara de Willink (1992) published by CABI and with permission of the author.

Ferrisia meridionalis Williams

(Fig. 13)

Ferrisia meridionalis Williams, 1985b: 255.

This South American species has been recorded from Argentina, Chile, Paraguay and Uruguay on several unrelated host plants (Williams 1985b; Williams & Granara de Wıllink 1992). The holotype is from San Vincente in Paraguay, where it was collected on the leaves of *Manihot esculenta* (Euphorbiaceae). The diagnostic features of the adult female of *F. meridionalis* are the complete absence of multilocular pores (including from around the vulva), the absence of small tubular ducts marginally, the presence of minute translucent pores on the dorsal surface of the hind coxa, the minute pores on the rim of the dorsal enlarged tubular ducts touching the rim of the duct opening (0–2 minute pores per duct), and two pairs of well-developed ostioles. The illustration of the adult female in Williams (1985b) and Williams & Granara de Willink (1992) has been reproduced here with some modification (Fig. 13).

We examined the holotype of this species (from the BMNH), as well as one adult female ex grape (Vitaceae) from Argentina (in USNM), another ex *Baccharis* (Asteraceae) from Uruguay (in USNM), and four adult females ex *Hypericum perforatum* (Hypericaceae) from Chile (three slides in BME, one in USNM).

Ferrisia milleri Kaydan & Gullan sp. n.

(Fig. 14)

urn:lsid:zoobank.org:act:D24DD971-A7FA-403A-B0A0-590D02B63BD7

Type material: **Holotype**: adult ♀, ex ? *Calophyllum* sp. leaf, PUERTO RICO, nr Sabana, 16.vii.1977, N-77-103, S. Nakahara (USNM). **Paratypes**: PUERTO RICO: 2 adult ♀♀ (1 slide) ex *Inga inga*, 14 km E of Mayaguez, 6.ii.1936, M.R. Smith, P.R. No: 1354 (USNM); 2 adult ♀♀ (1 slide) ex guaba [*Inga* sp.] leaves, Mayaguez, 20.xii.1935, M.R. Smith, P.R. # 876 (USNM); 1 adult ♀ (on slide with an adult ♀ of an unidentifiable *Ferrisia* sp.), ex *Inga inga*, San Sebastian, 5.xi.1935, M.R. Smith, Acc # P.R. 848 (USNM).

ADULT FEMALE. Diagnosis. *Ferrisia milleri* can be diagnosed by having the following combination of features: clusters of small oral-collar tubular ducts on ventral margins of all body segments, but ducts usually in loose clusters; ventral oral-collar tubular ducts generally associated with 1 or 2 discoidal pores around duct rim, pores nearly as large as duct opening and very close to duct opening, each 2.5–3.5 µm in diameter; dorsal enlarged tubular ducts totalling 51–68 throughout dorsum, rim of each duct mostly with 1 or 2 oval discoidal pores usually associated with rim of duct opening; number of multilocular disc pores on venter of abdominal segments as follows: 1–3 on VI, 12–20 on VII, and 10–23 on VIII + IX; both pairs of ostioles present and well developed; antennae 7 or 8 segmented.

Ferrisia milleri is most similar to *F. cristinae*, *F. ecuadorensis*, *F. kondoi* and *F. williamsi*, but can be distinguished readily by having clusters of small oral-collar tubular ducts on the ventral margins of all body segments (present on segments II–VIII in *F. ecuadorensis*, usually confined to VI–VII in *F. cristinae* and *F. williamsi*, and VI–VII or VII–VIII in *F. kondoi*). The adult female of *F. milleri* also differs from that of *F. virgata* in the position of the discoidal pores, which is adjacent to the rim of each duct opening of both dorsal enlarged tubular ducts and ventral oral-collar tubular ducts (discoidal pores rarely adjacent to rim of duct openings in *F. virgata*). This species is also similar to some specimens of *F. gilli* by having small oral-collar tubular duct clusters on all body segments, but can be separated from the latter by the presence of anterior ostioles and presence multilocular pores on abdominal segment VI (both features absent in *F. gilli*).

Description of slide-mounted specimens (based on all 6 type specimens; Fig. 14)**.** Body elongate oval, 2.98–3.52 mm long (holotype 2.57 mm), 1.68–1.92 mm wide (holotype 1.37 mm). Eye marginal, 68–90 µm wide. Antenna 7 or 8 segmented, 600–650 µm long; apical segment 120–130 µm long, 35–37 µm wide. Clypeolabral shield 170–195 µm long, 110–145 µm wide. Labium 210–235 µm long, 125–145 µm wide. Anterior spiracles 65–75 µm long, 45–50 µm wide across atrium; posterior spiracles 82–88 µm long, 52–68 µm wide across atrium.

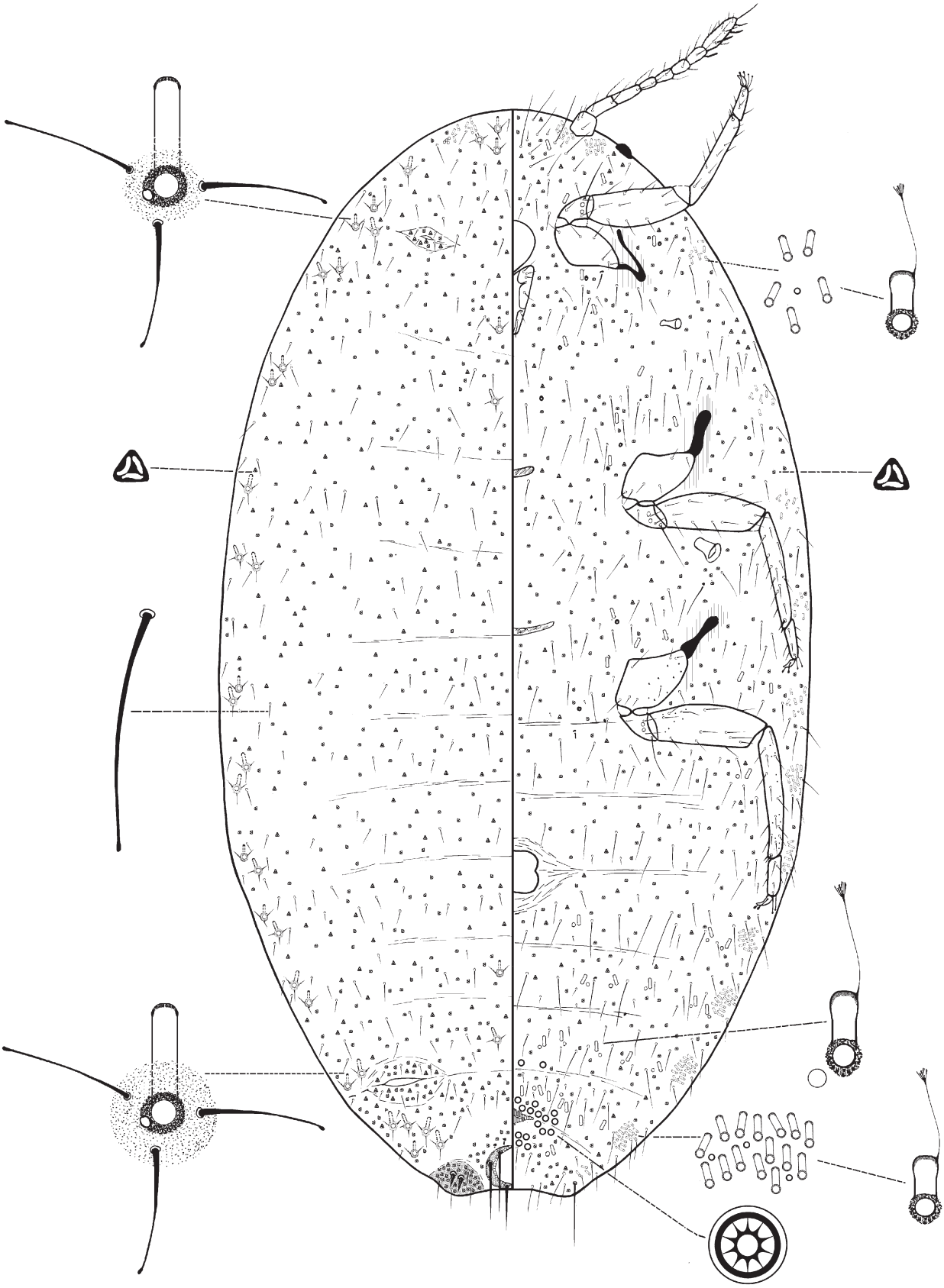

FIGURE 14. Adult female of *Ferrisia milleri* Kaydan & Gullan sp. n.

Circulus quadrate, 117–160 µm wide, divided by an intersegmental line. Legs well developed; hind trochanter + femur 470–500 µm long, hind tibia + tarsus 530–560 m long, hind claw 40–45 µm long. Ratio of lengths of hind tibia + tarsus to hind trochanter + femur 1.08–1.25, ratio of lengths of hind tibia to tarsus 3.00–3.07, ratio of length of hind trochanter + femur to greatest width of femur 3.91–4.27. Tarsal digitules subequal, each 60–63 µm long. Claw digitules subequal, each 35 µm long. Translucent pores present on hind legs, totalling 12–22 on coxa, femur and tibia combined. Ostioles: both pairs present; anterior ostioles poorly developed, each with 25–29 trilocular pores and 8 setae; each posterior ostiole with 33–46 trilocular pores and 7–11 setae. Anal ring 100–120 µm wide, with 6 anal ring setae, each seta 185–225 µm long.

Dorsum. Anal lobe cerarii each with 2 conical setae, each seta 35 µm long, with 27–47 trilocular pores and 3–5 auxiliary setae. Dorsal body setae slender, each 15–88 µm long. Trilocular pores each 4–5 µm in diameter. Enlarged tubular ducts totalling 51–68 on dorsum, each duct 25–33 µm long, 6–8 µm wide at mid-length, rim of duct opening 10–13 µm in diameter, surrounded by a sclerotised circular area 15–25 µm in diameter, enclosing 1 or 2 oval discoidal pores (each pore usually adjacent to rim of duct opening) and with 2–5 (generally 2 or 3) setae, each 25–38 µm long, usually either within rim of duct opening (especially on abdomen) or on edge of rim (especially on head); ducts distributed marginally in clusters of 1–4 on head and thorax, on margins of all abdominal segments in groups of 2–3, but with 4–6 ducts on each side of abdominal segment VII, and also 3–5 submedially on dorsum.

Venter. Body setae slender, each 15–240 µm long, longest setae medially on head; apical seta of anal lobe 300–305 µm long. Multilocular disc pores present on posterior abdominal segments only: 1–3 pores on segment VI, 12–20 on segment VII, 10–23 on segments VIII + IX; each pore 7.5–8.0 µm in diameter. Trilocular pores each 3–4 µm in diameter. Minute discodial pores each 2.5–3.5 µm in diameter, almost always associated with oral-collar tubular ducts, with 1 or 2 pores very close to (almost touching) rim of most oral-collar tubular ducts and 1 or 2 pores among many clusters of small oral-collar tubular ducts. Oral-collar tubular ducts on most of venter (excluding margins of posterior abdomen) each 9–10 µm long, 2.5–3.8 µm wide, totalling 67–74, distributed as follows: 17–22 on head and thorax, and on each abdominal segment: 10–12 total on segments I–III, 4–6, on IV; 4–10, on V; 4–12, on VI; 8–14, on VII, and 2–4 on VIII. Small oral-collar tubular ducts each 7.5–9.0 µm long, 3–4 µm wide, distributed on each side of body as follows: 13–19 on head at base of antennae, in loose segmental clusters of 2–11 ducts along margin of thorax; on each side of each abdominal segment: 3–10 on I; 3–10 on II; 9–15 on III; 7–15 on IV; 8–18 on V; 8–18 on VI; 10–17 on VII; 0–6 on VIII; ducts in each group not tightly clustered.

Etymology. This species is named in honour of Dr Douglass R. Miller, who assisted with this study in many ways, including hosting the authors' visits to Beltsville to examine *Ferrisia* specimens in the USNM, collecting *Ferrisia* samples for DNA work, and providing much useful advice.

Ferrisia multiformis Granara de Willink
(Fig. 15)

Ferrisia multiformis Granara de Willink, 1991a: 181.

This species was described and illustrated by Granara de Willink (1991) from *Parthenium* (Asteraceae) in Argentina based on the holotype and 10 paratype adult females (housed in IMLA, BMNH and USNM). We found no specimens of this species among the unidentified South American material that we examined. We examined the two paratype specimens housed in the USNM and noted the following diagnostic features: both pairs of ostioles are present, multilocular disc pores are present only posterior to the vulva, the dorsal enlarged tubular ducts never number more than two, the hind trochanter + femur is less than 300 µm long, with a ratio of hind trochanter + femur to tibia + tarsus of about 1.1, and the antennae are each about 400 µm long.

We have modified the original illustration of the adult female of this species (Fig. 15) based on examination of the paratypes in the USNM. The original drawing showed oral-collar tubular ducts dorsally, but this appears to be an error, possibly resulting from interpreting large discoidal pores as the openings of ducts.

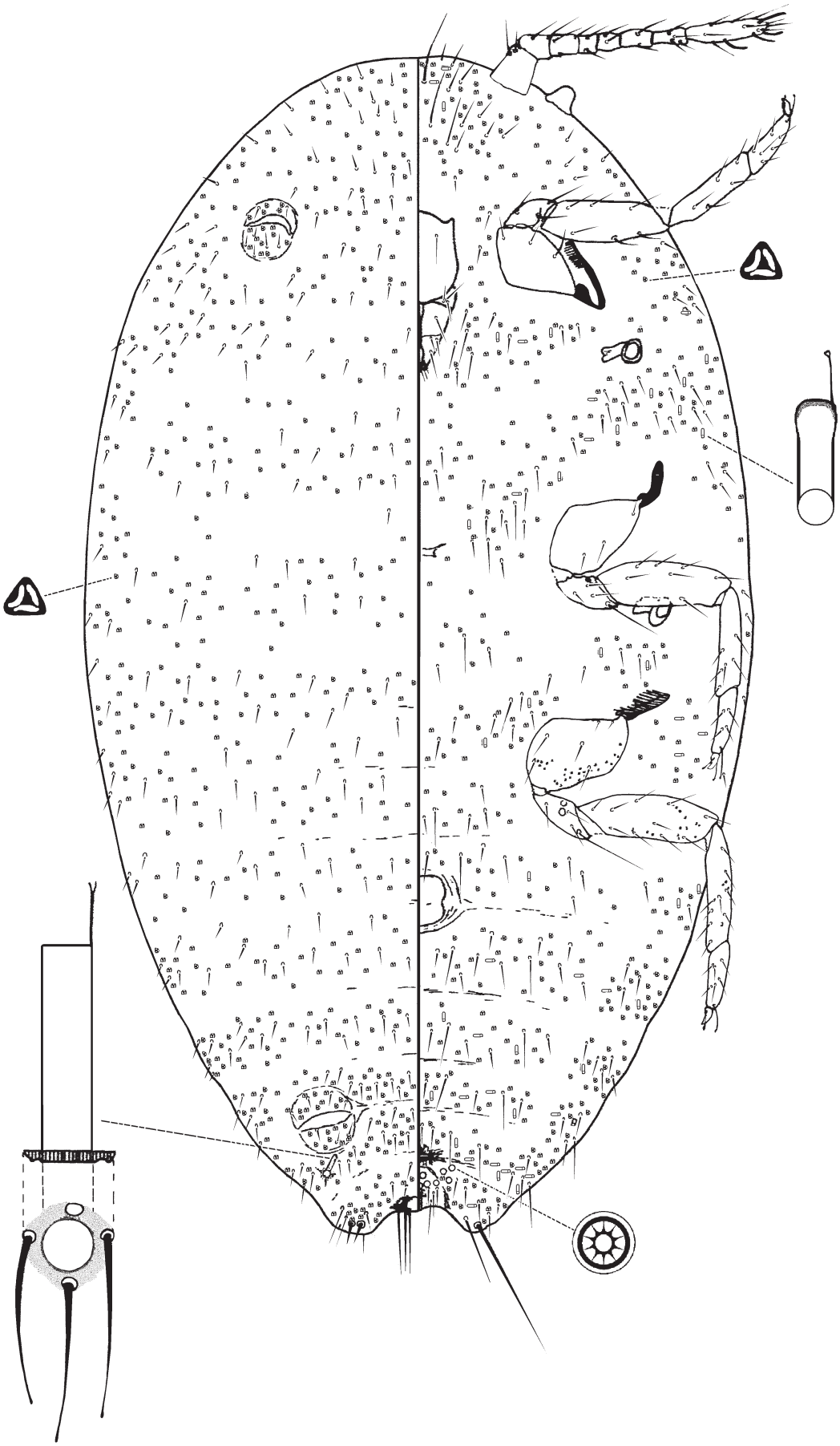

FIGURE 15. Adult female of *Ferrisia multiformis* Granara de Willink. Modified from figure 1 of Granara de Willink (1991) with permission of the author.

***Ferrisia pitcairnia* Kaydan & Gullan sp. n.**
(Fig. 16)
urn:lsid:zoobank.org:act:9387D25D-0AC6-41E8-827D-9C904B603A9F

Type material. **Holotype**: adult ♀ ex *Pitcairnia* sp., PUERTO RICO, Maricao, Road # 120, km 17.5, 5.xi.2003, D.R. Miller, UCDC type # 1791 (BME). **Paratypes**: PUERTO RICO: 8 adult ♀♀ (8 slides), 1 second-instar nymph (1 slide), same data as holotype (BME including DNA voucher ♀ FBK020, 1 adult ♀ BMNH); 27 ♀♀ (14 slides), 3 third-instar ♀♀ (3 slides), ex *Pitcairnia angustifolia*, Maricao, Reserva Forestal, 21.vii.1977, S. Nakahara, N-77-107 (USNM); 6 adult ♀♀ (5 slides), 1 third-instar ♀ (1 slide), 1 second-instar nymph (on slide with 2 adult ♀♀), ex tender inner leaf whorl of *Pitcairnia angustifolia*, Maricao, Maricao State Forest, Rt 120, km 9.5, 18°08'04"N, 66°57'18"W, 5.x.2006, Alex Segarra (BME including DNA voucher ♀ FBK044); 1 adult ♀ + 2 second-instar nymphs (all on 1 slide), on Bromeliaceae, quarantine intercept at DC., 1.viii.1935, C.E. Prince Jr., E.Q. No. 037200 (USNM).

ADULT FEMALE. Diagnosis. *Ferrisia pitcairnia* can be diagnosed by the following combination of features: small body size; absence of clusters of small oral-collar tubular ducts on ventral margins of abdominal segments; ventral oral-collar tubular ducts generally associated with 1 or 2 minute discoidal pores around the rim (each pore slightly larger than duct opening, 3–4 µm in diameter); dorsal enlarged tubular ducts totalling 13–27 throughout dorsum, rim of each duct often with 1 or 2 oval discoidal pores usually adjacent to duct opening; number of multilocular disc pores on venter as follows: 0–4 on abdominal segment V, 5–9 on VI, 12–27 on VII, and 12–23 on VIII + IX, sometimes 1 pore between labium and anterior spiracle on each side; both pairs of ostioles present and well developed; antennae 7 or 8 (mostly 7) segmented.

Ferrisia pitcairnia is most similar to *F. colombiana* but the two species can be easily separated by the much smaller size of *F. pitcairnia* (1.3–1.8 mm long, 0.5–1.0 mm wide) compared to *F. colombiana* (1.9–2.1 mm long, 1.0–1.2 mm wide); absence of translucent pores on hind legs (present in *F. colombiana*); and by the smaller number of ventral oral-collar tubular ducts (15–23 in *F. pitcairnia* and 55–75 in *F. colombiana*).

Description of slide-mounted specimens (based on holotype and 16 adult female paratypes; Fig. 16). Body elongate oval, 1.30–1.78 mm long (holotype 1.29 mm), 0.54–0.96 mm wide (holotype 0.68 mm). Eye marginal, 37.5–50 µm wide. Antenna 7 or 8 segmented, 275–350 µm long; apical segment 75–85 µm long, 25–33 µm wide. Clypeolabral shield 130–170 µm long, 135–160 µm wide. Labium 110–145 µm long, 85–120 µm wide. Anterior spiracles 42–55 µm long, 22–30 µm wide across atrium; posterior spiracles 52–70 µm long, 25–33 µm wide across atrium. Circulus quadrate, 72–85 µm wide, divided by an intersegmental line. Legs well developed; hind trochanter + femur 210–260 µm long, hind tibia + tarsus 215–265 µm long, hind claw 25–30 µm long. Ratio of lengths of hind tibia + tarsus to hind trochanter + femur 0.97–1.1, ratio of lengths of hind tibia to tarsus 1.50–1.86, ratio of length of hind trochanter + femur to greatest width of femur 2.77–3.57. Tarsal digitules subequal, each 37–50 µm long. Claw digitules subequal, each 25–35 µm long. Translucent pores absent on hind legs. Ostioles: both pairs present; each anterior ostiole with 18–27 trilocular pores and 5–6 setae; each posterior ostiole with 19–28 trilocular pores and 5–12 setae. Anal ring 67–83 µm wide, with 6 anal ring setae, each seta 125–213 µm long.

Dorsum. Anal lobe cerarii each with 2 conical setae, 17–28 µm long, with 21–25 trilocular pores and 3–7 auxiliary setae. Dorsal body setae short and slender, each 12–63 µm long. Trilocular pores each 3–4 µm in diameter. Enlarged tubular ducts totalling 13–27 on dorsum, each duct 23–27 µm long, 5.0–6.5 µm wide at mid-length, duct opening 6.5–8.0 µm in diameter, surrounded by a sclerotised circular rim 13–23 µm in diameter and typically enclosing 1 or 2 oval discoidal pores which are generally adjacent to duct opening, and with 1–5 (generally 2 or 3) setae, each 20–30 µm long, usually either within rim (especially on abdomen) or on edge of rim (especially on head); ducts distributed only marginally on head, thorax and abdominal segments; each segment with 0–2 enlarged ducts, but with 2 or 3 ducts on each side of abdominal segment VII.

Venter. Body setae slender, each 13–130 µm long, longest setae medially on head; apical seta of anal lobe 177–210 µm long. Distibution of multilocular disc pores as follows: 0–4 pores on abdominal segment V, 3–8 on segment VI, 12–18 on segment VII, 11–26 on segments VIII + IX, and sometimes 1 pore between anterior spiracle and labium; each pore 7–10 (mostly 8–9) µm in diameter. Trilocular pores each 2.5–4.0 µm in diameter. Minute discoidal pores each 2.5–4.0 µm in diameter scattered on venter and generally associated with oral-collar tubular ducts. Oral-collar tubular ducts minute, each 6.2–8.3 µm long, 2.5 µm wide, totalling 15–23, mostly together with 1 discoidal pore (rarely 2), distributed as follows: 5–8 on head and thorax, and on each abdominal segment: 0–3 total on segments I–III; 0–1 on IV; 0–1 on V; 1–3 on VI; 3–6 on VII; 0 or 1 (generally none) on VIII.

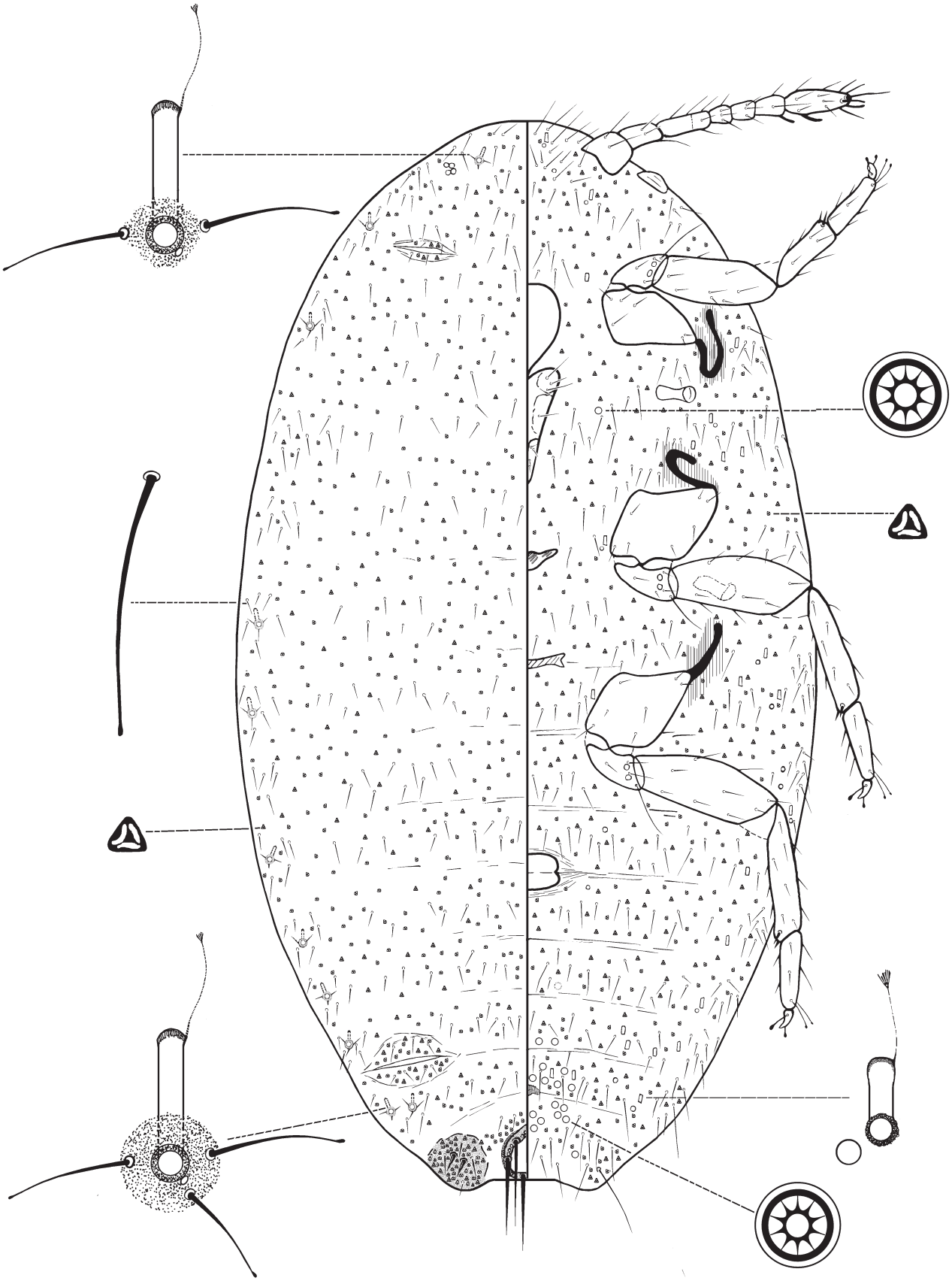

FIGURE 16. Adult female of *Ferrisia pitcairnia* Kaydan & Gullan sp. n.

Etymology. The species name is derived from the genus name of host plant *Pitcairnia.* The name should be treated as a noun in apposition.

Biological note. The collection of this species made by Alex Segarra on 5 October 2006 was from a clump of plants of *Pitcairnia angustifolia* growing on the ground under heavy shade at 2,600 feet [793 m] elevation on a SW facing slope, and most of mealybugs were protected within the tender inner leaf whorls (few on the exterior) and they were tended by small ants (A. Segarra, personal communication).

Ferrisia quaintancii (Tinsley)

(Fig. 17)

Dactylopius quaintancii Tinsley, 1898: 220.
Pseudococcus quaintancii (Tinsley); Fernald, 1903: 108. Change of combination.
Erium quaintancei (Tinsley); Lindinger, 1935: 122. Change of combination and misspelling of species name.
Eurycoccus quaintancei (Tinsley); Ferris, 1950: 86. Change of combination and misspelling of species name.
Eurycoccus copallinae Ferris, 1953: 349. **Syn. n.**
Ferrisiana quaintancei (Tinsley); Ferris, 1953: 362. Change of combination and misspelling of species name.
Ferrisia quaintancei (Tinsley); McKenzie, 1967: 179. Change of combination and misspelling of species name.

Type material examined. **Lectotype** of *Dactylopius quaintancii* Tinsley (designated by Williams (1996)): third-instar ♀ on slide with 2 other third-intar ♀♀, labelled: "153 TYPE / Dactylopius /Quaintancii / Type. Tinsl. / Lake City, Fla / Feb. 9. 1898 / on Rhus ~~sp.~~ copalina / coll. Quaintance" (USNM). **Paralectotypes:** 2 third-instar ♀♀ on same slide as lectotype and 5 third-instar ♀♀ on second slide with same data (USNM); 9 third-instar ♀♀ on 3 slides that are subsequent preparations from the dry type material, labelled: "Pseudococcus / quaintancii (Tins.) / Type / On Rhus sp. / [copallina] / Lake City, Florida / A.L. Quaintance colr. / Feb. 9, 1898" (USNM). There is also a box of dry material with "TYPE" printed on it and a label inside: "Dactylopius Quaintancii, Tins. / Type. On Rhus sp. / Lake City Fla. 2/9/98 / Coll. A.L. Quaintance." (USNM), but there appear to be no insects remaining in the box.

Lectotype (here designated) of *Eurycoccus copallinae* Ferris: adult ♀ on slide with a second adult ♀, labelled: "Trionymus / quaintancei (Tins) / From crown of / Rhus / copalina / Gainesville, Fla. / July, 1918 / C. J. Drake, coll. / GFF [=G.F. Ferris]", UCDC type # 1789 (BME). **Paralectotypes:** 1 adult ♀ on same slide as lectotype (BME); 4 adult ♀♀, 2 on each of 2 slides labelled: "Trionymus / quaintancei / (Tins) / On roots of Rhus / copalina [sic] / Gainesville, Fla. / July 7, 1918 / C. J. Drake, coll. / GFF" (one slide in each of BME and FSCA); 2 adult ♀♀, on slide labelled: "Trionymus / quaintancei / (Tins.) / On sumac. / Ft. Meyers Fla. / From J. Chaffin / 1919 / GFF" (BME); 6 adult ♀♀ slide-mounted by M.B. Kaydan 2006 from dry material in box with one label: "Pseudococcus quaintancei Tins. / On crowns of Rhus copalina / Gainesville, Fla. / July, 1918 C.J. Drake, coll. / G.F. Ferris det." (BME).

Other material examined. UNITED STATES OF AMERICA, Florida: 2 adult ♀♀ (2 slides), ex *Rhus* sp., Apopka, 16.v.1973, W. H. Pierce (USNM); 1 adult ♀, 4 second-instar ♀♀ (5 slides), ex roots of *Rhus copallina*, Alachua, Kanapaha Pines, near Arredondo, between Gainesville & Archer, 22.xi.2002, S. Halbert & D. R. Miller (BME); 2 adult ♀♀ (1 slide), ex Sumac, Gainesville, Sept. 1918, from J. Chaffin 1919 (BME); 2 third-instar ♀♀ (2 slides), ex *Rhus* sp., Gainesville, 17.xii.1972, W. H. Pierce, DPI #125834 (USNM); 3 adult ♀♀ (3 slides), ex *Rhus* sp., Old Town, 5.x.1977, W. H. Pierce, DPI-126243 (1 slide FSCA, 2 slides USNM); 2 adult ♀♀ (2 slides), ex *Rhus* sp., Sorrento, 5.xii.1972, W. H. Pierce, DPI #125835 (USNM).

The only records of *F. quaintancii* are from *Rhus copallina* (Anacardiaceae) in Florida, U.S.A. It is likely that the species always occurs on the roots or crown of its host plant, although the position on the host was not recorded for more than half of the collections and not specified in the original descriptions by Tinsley (1898) and Ferris (1950). Tinsley's (1898) description is of the third-instar female, misidentified as an adult. The colour in life was recorded as greyish-brown but the body was described as so covered in white wax secretion that the true colour showed only on the venter. Tinsley's type material in the USNM consists of two original slides with a total of eight third-instar females and three subsequent slides with a total of nine third-instar females and the same type data. A lectotype was designated by Williams (1996), who stated that one specimen lacked dorsal enlarged tubular ducts and the others possessed ducts laterally on the posterior abdomen, often totalling only one

or two ducts. The lectotype has three dorsal enlarged tubular ducts, each with only one seta, and one duct also has a minute pore on the sclerotised rim.

Ferris (1950) described and illustrated the adult female of *F. quaintancii* (redrawn here, Fig. 17) but in a different genus and misspelt the species name as *Eurycoccus quaintancei*. He used specimens collected from *Rhus* in Gainesville and Fort Meyers, Florida. After examining Tinsley's types of *D. quaintancii*, Ferris (1953) believed that he had misidentified the species and so proposed the name *Eurycoccus copallinae* for the insects that he had described in 1950. The BME has 12 adult females (see type data above) that bear the data given in Ferris (1950) plus an additional slide with two adult females collected from sumac at Gainesville, Florida, in September 1918. The FSCA has one slide (of two adult females) that must have been obtained from Ferris because it has exactly the same label as one of the BME slides, including the printed words "Entomological Collection Stanford University" which appear on almost all Ferris slides. Twelve of these 16 adult females totally lack enlarged tubular ducts on the dorsum, and the other four females either have one, two or four of these ducts. We believe that Ferris (1950) was correct in identifying the specimens from *Rhus* in Florida as *F. quaintancii*. All adult females collected from this host in Florida (see specimens listed under "Other material examined" above) have very few dorsal enlarged tubular ducts, similar to the third-instar females of the type series of *D. quaintancii*.

A further complication is the possibility that *F. gilli* and *F. quaintancii* are the same species, even though the adult females differ substantially in the number of enlarged tubular ducts on the dorsum, and females of *F. quaintancii* seem always to lack clusters small ventral tubular ducts marginally on the body (in *F. gilli* these ducts are in segmental clusters at least on the posterior segments). On adult females of *F. quaintancii* (types of *E. copallinae*) there are 0–4 enlarged tubular ducts on the dorsum (if present, always on the posterior abdomen) compared with 90–120 ducts distributed on all body segments on the type adult females of *F. gilli*. The third-instar females of the type series of *D. quaintaincii* have 1–4 enlarged tubular ducts on the dorsum (n = 15 females) except one female has 10 ducts, and the ducts are confined to the abdomen, mostly on segments V–VII and often marginally on abdominal segment I, but rare on segments II–IV, whereas third-instar females from the type series of *F. gilli* from pistachio and grass in California have 62–74 enlarged tubular ducts on the dorsum with ducts on all body segments (n = 6 females). Gullan *et al.* (2010) sequenced the DNA from one second-instar nymph (voucher FBK016), collected from the roots of *R. copallinae* in Florida. This specimen has a total of 20 enlarged tubular ducts on the dorsum, compared with 30–38 ducts on 12 second-instar nymphs from the type series of *F. gilli* from pistachio and almond in California. Prior to DNA sequencing, it was assumed that the nymph from Florida was *F. quaintancii* based on its host plant, location and association with one slide-mounted adult female resembling *F. quaintancii* (i.e., having a total of just three dorsal enlarged tubular ducts). However, the DNA of the nymph showed that it belonged to clade F along with specimens of *F. gilli* (Fig. 3). Either *F. gilli* is the same species as *F. quaintancii* or there was a mixed collection of two *Ferrisia* species in the sample from which nymph FBK016 was taken, or there was an error during processing for sequencing. Given this uncertainty and the huge morphological disparity between adult females of *F. gilli* and *F. quaintancii*, we have taken the conservative approach of retaining both names until further data can be accrued. We note though that *F. quaintancii* appears confined to the roots and crowns of *Rhus*, a member of the Anacardiaceae, and that pistachio, also a member of the Anacardiaceae, is a favoured host of *F. gilli* in California. It is not known whether *F. gilli* can live and develop on the roots of pistacio trees, but overwintering nymphs have been recorded sheltering below the soil around the base of trees, sometimes several inches below ground (Gullan *et al.* 2003).

The adult female of *F. quaintancii* is most similar to those of *F. claviseta*, *F. gilli* and *F. setosa* in lacking the anterior pair of ostioles. However, the adult female of *F. setosa* (Fig. 18) is distinctive in having an anal ring mostly with more than 12 anal ring setae (6 setae in the other three species) and fewer than 6 multilocular pores near the vulva (many more pores in the other species). The adult female of *F. quaintancii* can be distinguished from that of *F. gilli* by the features listed in the paragraph above and also by having many more ventral oral-collar tubular ducts in a transverse row across most abdominal segments. It differs from the adult female of *F. claviseta* by the lack of paired minute pores associated with the rim of the enlarged tubular ducts of *F. claviseta* and by having many more ventral oral-collar ducts on the abdomen (refer to the key to species and compare Figs 5 and 17).

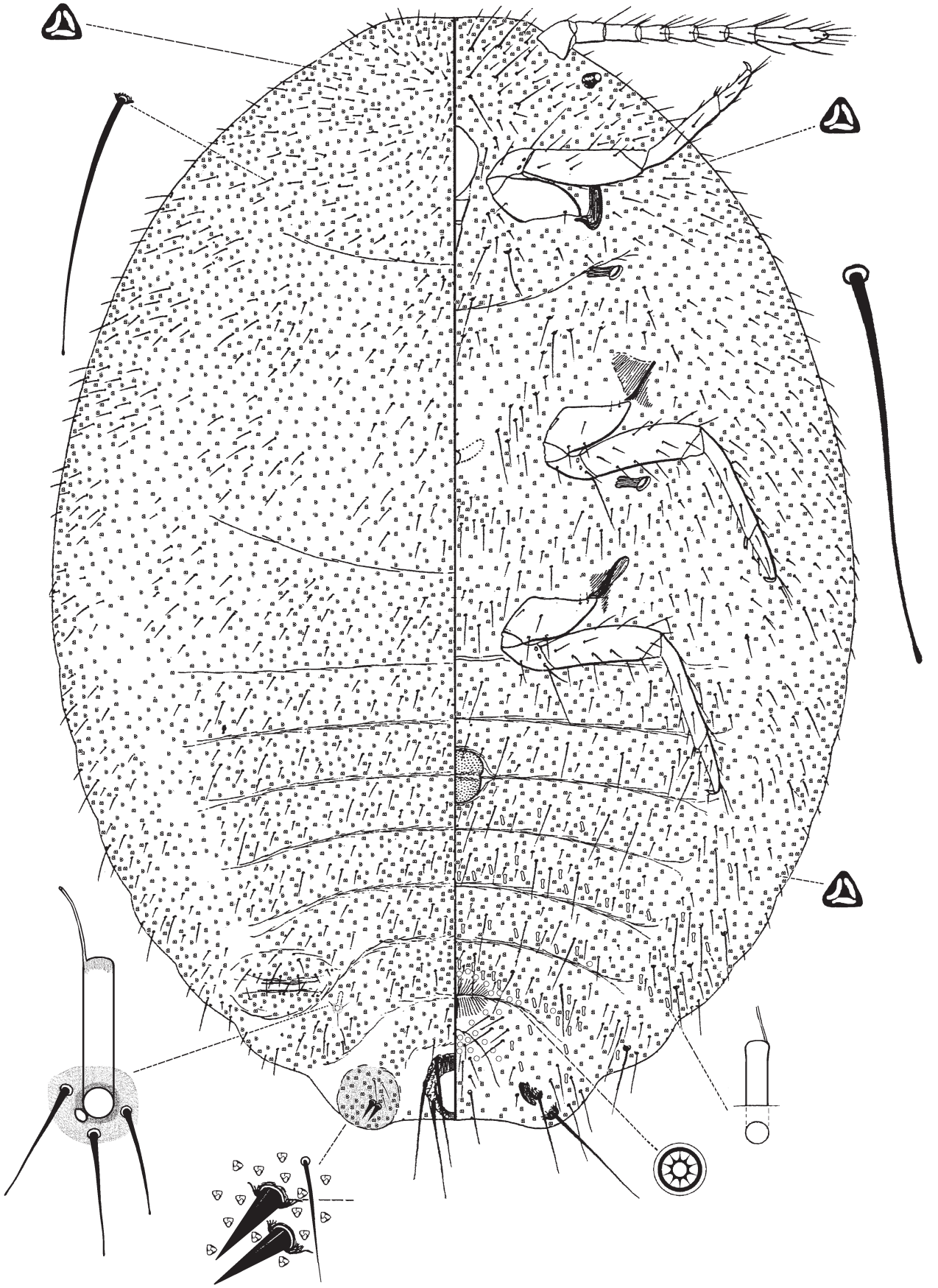

FIGURE 17. Adult female of *Ferrisia quaintancii* (Tinsley). Note that although only one dorsal enlarged tubular duct is illustrated, there can be from none to four of these ducts present. Modified from figure 32 of Ferris (1950) published by Stanford University Press.

***Ferrisia setosa* (Lobdell)**
(Fig. 18)

Trionymus setosus Lobdell, 1930: 220.
Erium setosum; Lindinger, 1935: 122. Change of combination.
Ferrisiana setosa; Ferris, 1950: 91. Change of combination.
Ferrisia setosa; McKenzie, 1967: 179. Change of combination.
Ferrisia lobdellae Varshney, 1982: 857. Unjustified replacement name; discovered by Ben-Dov, 1994: 164.

Type material examined. **Holotype** of *Trionymus setosus* Lobdell: adult ♀, larger specimen (4.0 mm long, 2.5 mm wide) on slide with 1 other adult ♀, slide labels: "~~Lachnodiella~~ / ~~liquidambaris~~ / On Sweet Gum Roots / Durant, Miss. / Prop. ? / Coll. G.R. Williams / Sept. 18, 1926 / S. R. 9740 Draw [this word in pencil]" and "Trionymus / setosus n. sp. / On Sweet gum roots / Prop. ? / G.R. Williams, Coll. / Sept. 18, 1926 / S. R. 9740"; slide envelope: "setosus n. sp. Durant Sept 18, 1926 / on sweet gum roots Holotype / Trionymus S.R.9740" (MEM). **Paratypes:** 1 adult ♀, on same slide as holotype (MEM); 5 adult ♀♀ (1 slide), same data as holotype but envelope also says "On Sweetgum near ground attended by ants / Paratype" (MEM); 1 adult ♀, same data as holotype except labelled as "Paratype" and host given as *Liquidamber styraciflua* (USNM); 10 adult ♀♀ (5 slides), labels: "Type material" and "Trionymus / setosus Lobd. / On Sweet gum / Durant, Miss. / Coll. G.R. Williams / 9-18-26 / L.E.M. (BME); 6 first-instar nymphs (1 slide), labels: "Trionymus / setosus n. sp. / crawlers on Sweet gum / Bird Reserve / A & M. College, Miss / J. N. Roney, Coll. / Crawlers Sept 28 from / Durant, Miss." and "Crawlers / from Durant / Miss. Sept. 28, / 1926. Second / generation / crawlers / Dec 3, 1926" and envelope also says "Paratype"(MEM); 1 adult ♀ (mature and broken apart) with 4 embryos (1 slide), labels: "Trionymus / setosus n. sp. / larva & adults / On sweet gum / Bird Reserve / A & M College, Miss. / J.N. Roney, Coll. / Dec. 3, 1926 / #602" and "Crawlers / placed on shrub / Sept 28, 1926 / From Durant, / Miss. anal ring [previous two words in pencil] / Mature adult / with larvae / Dec 3, 1926" (MEM). The USNM also has a small box of dry adult ♀♀, here considered as paratypes, with labels: "Lachnodiella liquidambaris m.s. / on Liquidamber styraciflua / (Sweet gum) / Durant Miss. / G.R. Williams, Coll. / Sept. 1926 / In "cow sheds" / built by ants" and also "Paratype" [on outside of box]. The label data match the collection information in the original description, which uses both the scientific and common names of the host plant and refers to "cowsheads" built by ants.

The holotype slide is broken in two, as noted by Schiefer (2000), and the mountant of two of the paratype slides from MEM is dried out and cracked. Also as noted by Schiefer (2000), some of Lobdell's type material is missing (e.g., Lobdell described a second-instar female but only adult females and first-instar nymphs are represented in collections) and for the MEM slides the type designations are written only on the envelopes and not on the slides. Furthermore, the slide in the envelope bearing the holotype designation has two adult females but no explicit indication of which is the holotype. We here recognise the larger and more intact specimen as Lobdell's holotype because the smaller female is so damaged that it could not have been drawn and the label seems to indicate that the illustration was made from this slide. We consider the two slides of specimens collected on 28 September 1926 to be part of the type series because, although Lobdell (1930) lists the original collection as made on 18 September 1926, she states that the descriptions of the first-instar nymph and adult female were made from material collected on 28 September. She also states that an immature female was reared at A. & M. College until slide-mounted on 26 October. The original description gives the number of anal ring setae as 12–36; 12 is atypically low number of anal ring setae, but the mature and broken female that was reared and then collected on 3 December 1926 has 12 anal ring setae and the label has a pencil annotation "anal ring", suggesting that Lobdell saw the unusual anal ring and used this female as part of the description. The five slides of adult females in the BME are part of the G.F. Ferris collection and one slide also has an additional label: "Ferrisiana / setosa / (Lobdell)", which was the name used by Ferris (1950) in his redescription. Lobdell (1930) makes no mention of specimens being sent to Ferris and we believe that this material must have been acquired by him much later, presumably from the MEM. We consider these BME specimens to be part of the type series and we here treat them as paratypes.

Other material examined. U.S.A., Mississippi: 6 adult ♀♀ (3 slides), ex sweet gum, Goodman, 12.x.1927, G.R. Williams, attended by *Crematogaster laeviuscular* (MEM); 1 adult ♀, same locality as previous but collected 12.x.1928, M.R. Smith (MEM); 8 adult ♀♀ (4 slides), ex sweet gum, Mayhew, 14.iv.1927, M.R. Smith (3 slides MEM, 1 slide USNM); 3 adult ♀♀ (1 slide), ex sweet gum, West Point, 52E Broad St., vii.1929, L. H. Shropshire (MEM).

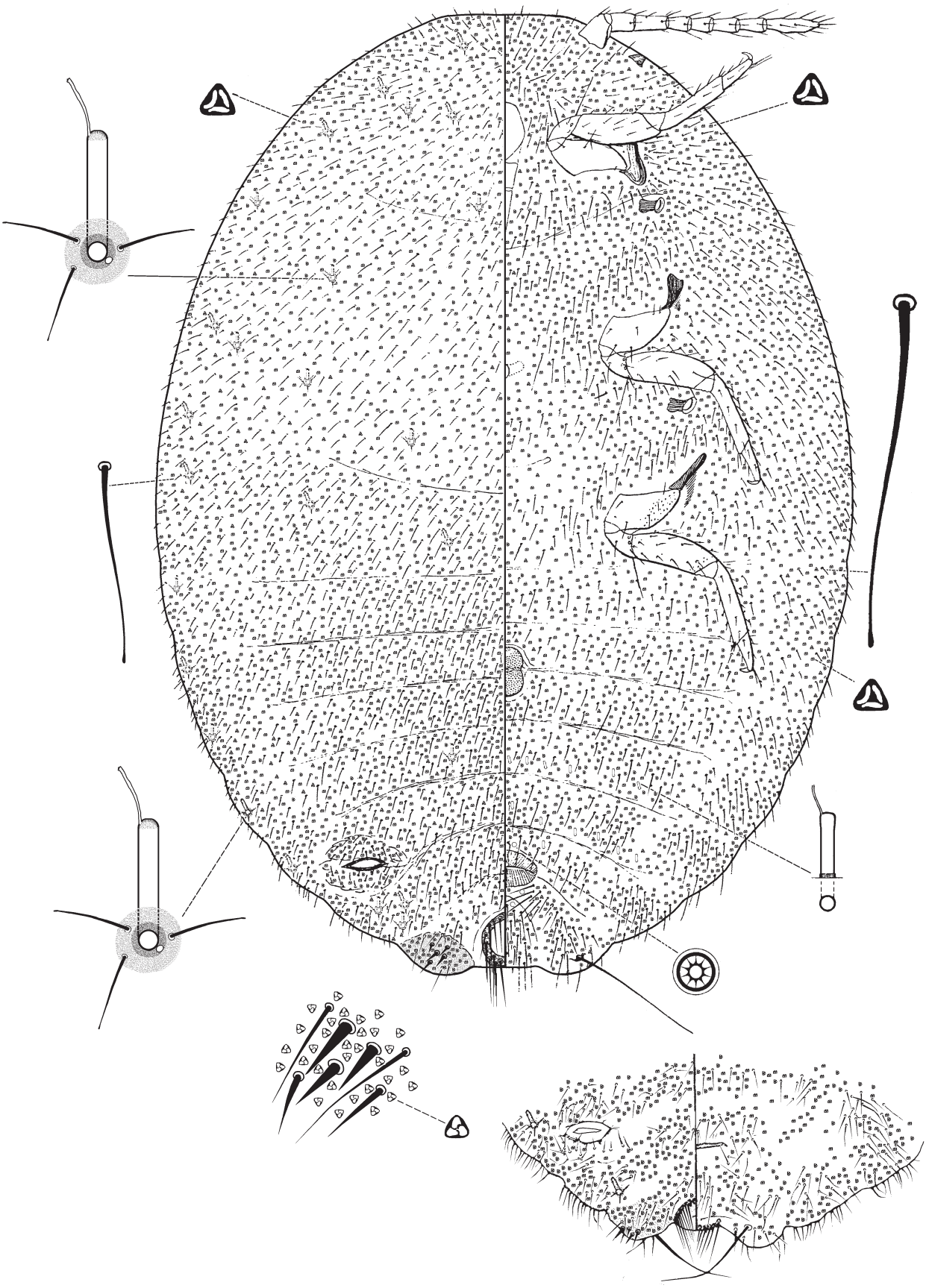

FIGURE 18. Adult female of *Ferrisia setosa* (Lobdell). Modified from figure 34 of Ferris (1950) published by Stanford University Press with the enlargement of the posterior abdomen from part of plate XIII of Lobdell (1930).

The only records of this species are from (i) the original 1926 collection from Durant, Mississippi, U.S.A., where it was found near the roots of sweet gum, *Liquidambar styraciflua* (Altingiaceae), under shelters built by Argentine ants [*Linepithema humile* Mayr] (Lobdell 1930) and (ii) from non-type slides of specimens, also from sweet gum in Mississippi (as listed above). The adult female was described and illustrated by Lobdell (1930) and Ferris (1950) (redrawn here, Fig. 18). This species is most similar to *F. claviseta*, *F. gilli* and *F. quaintancii* as the adult female of all four species lacks the anterior pair of ostioles, and all four species are native to the southeastern U.S.A. However *F. setosa* is most distinctive in having an anal ring with numerous anal ring setae (12–36, compared with six in all other *Ferrisia* species). Also each anal lobe cerarius has two to four conical setae, and the openings of the posterior pair of ostioles are lightly sclerotised. There are abundant setae on the abdomen and these are especially noticeable on the venter posterior to the vulva. Multilocular pores are restricted to a few around the vulva and these typically number 1–3 or can be absent. There are about 50 enlarged tubular ducts on the dorsum, mostly marginally around body and usually with one duct on each side of each abdominal segment. There appears to be no recent collections of this species.

Ferrisia terani Williams & Granara de Willink
(Fig. 19)

Ferrisia terani Williams & Granara de Willink, 1992: 181.

Type material examined. Paratype: 1 adult ♀, ex *Citrus*, ARGENTINA, Tucumán, 26.vii.1977, C. Granara de Willink (USNM).

Other material examined. 2 adult ♀♀ (2 slides, DNA vouchers FBK015 & PG90), ex *Citrus*, ARGENTINA, Tucumán, S. M. de Tucumán, May 2002, M.C. Granara de Willink (BME); 1 adult ♀, ex *Persea* sp., MEXICO, San Antonio, 15.vi.1972, C. Parker, 4009 (USNM); 1 adult ♀, ex leaf of *Eriobotrya* sp., MEXICO, intercepted at Los Angeles 049882, 27.v.1985, D. Roll, 85-8491 (USNM); 2 adult ♀♀ (on slide with a non-*Ferrisia* mealybug), ex *Jodina rhombifolia*, URUGUAY, Colonia Suiza, H.L. Parker, received 7.ix.1944, So. Amer. Par. Lab., 869-10 (USNM); 2 adult ♀♀ (2 slides), ex *Vaccinium ashei*, USA, Florida, Hawthorne, 21.xi.1997, J. Beckwith, E97-4417 (FSCA).

Other material of doubtful identity (not totally typical of *F. terani*): 1 adult ♀, ex *Opuntia* sp., MEXICO 18.ii.1993, H. Griab, El Pugo 42832, 93 03393 (USNM). This female has wider enlarged tubular ducts (width at duct mid-length: 6.0–7.3 µm on head; 7.0–8.3 µm on posterior abdomen) than typical specimens of *F. terani* (see below), but the ducts may have been distorted by overheating in KOH during clearing. The antennae (ca. 700 µm long) and legs of this Mexican specimen also are slightly longer than these appendages on the paratype of *F. terani* that we examined.

This species was described from citrus and cassava in Argentina and Guatemala (Williams & Granara de Willink 1992). Other collections (listed above) suggest that the species is quite widespread in South America and Mexico and also polyphagous, with host-plant records from Ericaceae, Euphorbiaceae, Lauraceae, Rosaceae, Rutaceae and Santalaceae, and perhaps also Cactaceae if the female from *Opuntia* belongs to this species.

The adult female is described and well illustrated in the original description (redrawn and modifed here, Fig. 19). It resembles the adult female of *F. malvastra* in having multilocular pores around the vulva only (fewer than 9 pores for *F. terani*) and having narrow dorsal enlarged tubular ducts, with a shaft diameter of 4.0–5.0 µm at mid-length (unless the specimen has been over-cleared in KOH, which distorts duct width), with the ducts narrower on the head than on the abdomen. The adult female of *F. terani* can be distinguished from that of *F. malvastra* by its slender body shape (body broadly oval for *F. malvastra*) and by having the dorsal enlarged tubular ducts on the posterior abdominal segments with the associated setae situated inside a large sclerotised area surrounding each duct (setae usually situated on the edge of a small sclerotised area surrounding each duct in *F. malvastra*).

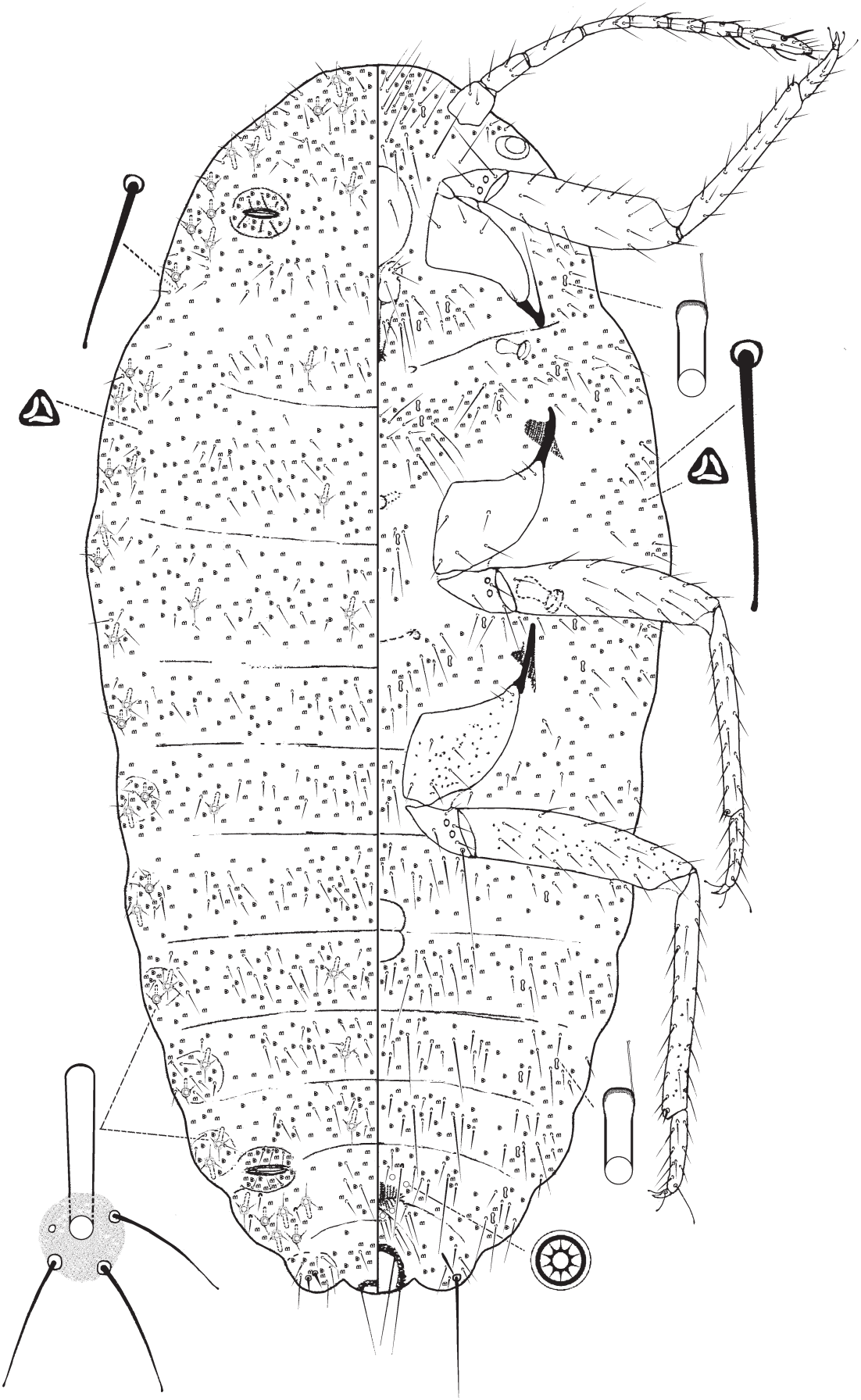

FIGURE 19. Adult female of *Ferrisia terani* Williams & Granara de Willink. Modified from figure 68 (drawn by D.J. Williams) in Williams & Granara de Willink (1992) published by CABI and with permission of the author.

***Ferrisia uzinuri* Kaydan & Gullan sp. n.**
(Figs 2F, 20)

urn:lsid:zoobank.org:act:ECC88117-299B-4944-94F9-3371DFBD49F6

Type material: Holotype adult ♀, ex silver buttonwood, *Conocarpus erectus*, BAHAMAS, Paradise Is., Atlantis Hotel, vii.2002, R. Warkentin, UCDC type # 1793 (BME). **Paratypes:** 23 adult ♀♀, same data as holotype (20 BME including DNA voucher ♀ FBK007, 3 BMNH); 1 adult ♀, ex *Codiaeum* sp. leaf, BAHAMAS, New Providence, 5.iii.1978, Nassau 1505, C.W. Smith (USNM); 1 adult ♀ ex *Croton* leaf, BAHAMAS, New Providence, 24.iv.1979, Nassau 1606, C.W. Smith (USNM); 2 adult ♀♀ (2 slides), ex *Trema lamarckiana*, BAHAMAS, Freeport, 18.x.1992, Survey team (FSCA); 1 adult ♀, ex *Croton* sp., BAHAMAS, Abola [misspelling of Abaco], Treasure Key, 28.x.1992, H.W. Browning (FSCA); 1 adult ♀, ex *Citrus* sp. leaf, DOMINICAN REPUBLIC, 29.viii.1981, JFKIA 41214, G. Bange (USNM); 2 adult ♀♀ (1 slide), ex *Phaseolus* sp., HAITI, 3.ii.1980, JFKIA 32932, D. Kepich (USNM); 6 adult ♀♀ (6 slides), ex *Conocarpus* sp., USA, Florida, Dade Co., Florida City, Comfort Inn Hotel, 8.v.2002, J.F. & D.R. Miller (4 BME including DNA voucher ♀ FBK023, 2 USNM); 7 adult ♀♀ (3 slides) and 4 adult males (3 slides), ex *Coccoloba uvifera*, USA, Florida, Key Largo, Jan. 1978, Uzi Nur, species FK (USNM); 4 adult ♀♀, ex *Conocarpus* sp., USA, Florida, Key Largo, Travernier, 500 Burton Dr. in grounds of Ocean Pointe apartments, 23.xi.2002, P.J. Gullan (BME including DNA voucher ♀ FBK008); 1 adult ♀, ex *Coccoloba uvifera*, USA, Florida, Dade Co., Miami, 27.x.1988, R. Erb (FSCA); 1 adult ♀, ex *Conocarpus erectus*, USA, Florida, Miami, 17.ix.1987, D. Storch (FSCA); 1 adult ♀, ex *Cocos nucifera*, USA, Florida, Princeton, 30.iv.1997, E97-1847, E.T. Putland (FSCA); 3 adult ♀♀ (1 slide), ex *Conocarpus erectus* var. *sericeus*, USA, Florida, Lee Co., Cape Coral, 320 SW 3rd Pl., 2.ii.2005, D. Renz, E2005-600-301 (FSCA); 4 adult ♀♀ (1 slide), ex *Conocarpus erectus*, WEST INDIES, St Barthelemy, 18.iv.2000, D. Meyerdirk (USNM).

ADULT FEMALE. Diagnosis. *Ferrisia uzinuri* can be diagnosed by the following combination of features: absence of clusters of small oral-collar tubular ducts on ventral margins of all abdominal segments; ventral oral-collar tubular ducts often with a discoidal pore touching rim, pore sometimes indistinct and usually only slightly smaller than opening of associated duct; dorsal enlarged tubular ducts totalling 63–117 throughout dorsum, rim of each duct usually with 1 or 2 oval discoidal pores typically adjacent to duct opening; auxiliary setae short (12–28, usually ≤20, µm long) and slender; dorsal setae scarce, scattered and very short compared with ventral setae, each 12–38 (mostly 20–30) µm long; multilocular disc-pores on venter of abdominal segments VI (5–9), VII (12–27), and VIII + IX (12–23); anal lobe cerarii each with 2 conical setae; both pairs of ostioles present but anterior pair weakly developed.

Ferrisia uzinuri is similar to *F. virgata* and *F. kondoi* but the adult female has a shorter body than adult females of these two species, and slide-mounted specimens of *F. uzinuri* can be distinguished most readily by lacking clusters of small oral-collar tubular ducts on the ventral margins of the abdominal segments (usually present on segments VI–VIII or VII–VIII for *F. kondoi* and on VII–VIII for *F. virgata*) and generally shorter dorsal setae (up to 38 µm long in *F. uzinuri*, compared with up to 60 µm long in *F. kondoi* and up to 65 µm long in *F. virgata*). The adult female of *F. uzinuri* also differs from that of *F. virgata* in the position of the discoidal pores which, if present near a duct, are always adjacent to the duct opening for both enlarged ducts and ventral oral-collar tubular ducts (discoidal pores never adjacent to duct openings in *F. virgata*). This species also shares some morphological similarity with *F. malvastra* and *F. terani*, but can be separated from these species by having more (always more than 2) multilocular disc pores ventrally on abdominal segment VI.

Description of slide-mounted specimens (based on holotype and 16 paratypes; Fig. 20). Body 1.88–2.96 mm long (holotype 1.93 mm), 0.96–1.85 mm wide (holotype 0.97 mm). Eye marginal, 45–75 µm wide. Antenna 8 segmented, 420–540 µm long; apical segment 90–110 µm long, 27–32 µm wide. Clypeolabral shield 135–175 µm long, 130–160 µm wide. Labium 137–185 µm long, 87–120 µm wide. Anterior spiracles 55–75 µm long, 30–45 µm wide across atrium; posterior spiracles 62–90 µm long, 42–60 µm wide across atrium. Circulus oval, 102–160 µm wide, divided by intersegmental line. Legs well developed; hind trochanter + femur 310–420 µm long, hind tibia + tarsus 320–400 m long, hind claw 30–35 µm long. Ratio of lengths of hind tibia + tarsus to hind trochanter + femur 0.9–1.1, ratio of lengths of hind tibia to tarsus 2.2–2.8, ratio of length of hind trochanter + femur to greatest width of femur 4.2–4.9. Tarsal digitules subequal, each 47–55 µm long. Claw digitules subequal, each 30–35 µm long. Translucent pores present on hind legs, totalling 15–41 on coxa, femur and tibia combined. Ostioles: both pairs present; each anterior ostiole poorly developed, with 19–24 trilocular pores and 5–6 setae; each posterior ostiole with 21–48 trilocular pores and 5–12 setae. Anal ring 102–160 µm wide, with 6 anal ring setae, each seta 180–238 µm long.

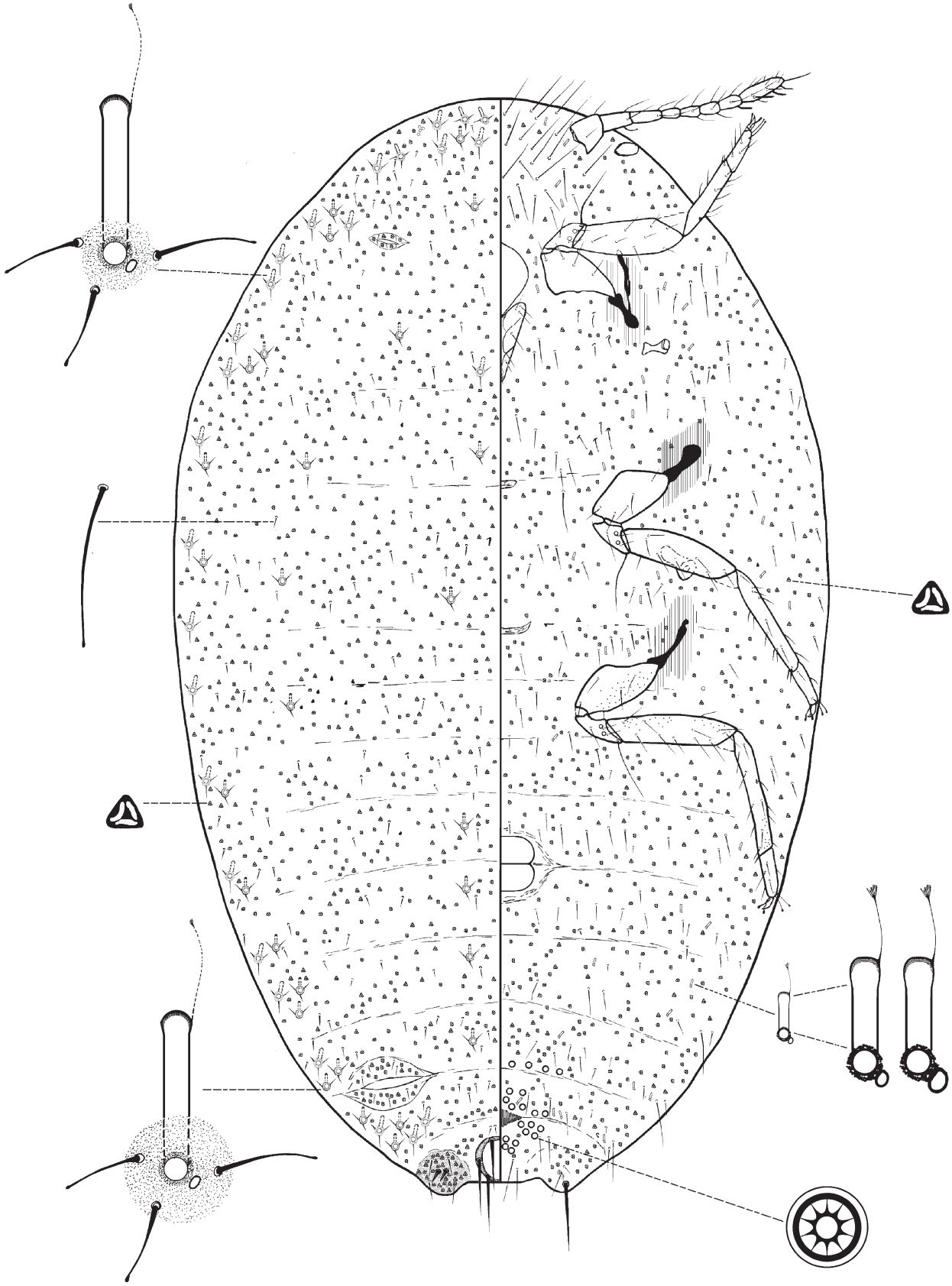

FIGURE 20. Adult female of *Ferrisia uzinuri* Kaydan & Gullan sp. n.

Dorsum. Anal lobe cerarii each with 2 conical setae, 27–35 µm long, with 18–37 trilocular pores and 3–6 auxiliary setae. Dorsal body setae short and slender, each 12–38 µm long. Trilocular pores each 4–5 µm in diameter. Enlarged tubular ducts totalling 63–117 on dorsum, each duct 30–35 µm long, 5–6 µm wide at mid-length, duct opening surrounded by a circular sclerotised rim 8–13 µm in diameter and enlarged sclerotised circular area 15–25 µm in diameter, enclosing 1–2 oval discoidal pores (generally adjacent to duct opening) and with 1–5 (generally 2–3) setae, each 12–28 (usually ≤20) µm long, usually either within rim (especially on abdomen) or on edge of rim (especially on head); ducts distributed marginally in clusters of 2–6 on head and thorax, on margins of all abdominal segments in groups of 2–5 (mostly 2–3), but with 6–9 ducts on each side of abdominal segment VII, and also 5–7 medially to submarginally on head and thorax, 3–4 medially on abdominal segments.

Venter. Body setae slender, each 12–175 µm long, longest setae medially on head; apical seta of anal lobe 205–263 µm long. Multilocular disc pores present on posterior abdominal segments only: 5–9 pores on segment VI, 12–27 on segment VII, 12–23 on segments VIII + IX; each pore 7–10 (mostly 7–8) µm in diameter. Trilocular pores each 3–4 µm in diameter. Discodial pores each 1.0–2.5 (generally 2.0) µm in diameter, almost always associated with oral-collar tubular ducts, usually only slightly smaller than opening of associated duct but often indistinct, with 1 pore (rarely 2) touching rim of most oral-collar tubular ducts. Oral-collar tubular ducts each 8.7–10.0 µm long, 2.5 µm wide, totalling 22–37, distributed as follows: 10–24 on head and thorax, and on abdominal segments: 2–4 total on segments I–III; 2–5 on IV; 2–5 on V; 2–5 on VI; 6–11 on VII; 0–2 (generally none) on VIII; no clusters of oral-collar tubular ducts present on body margin.

Etymology. This species is named for the late Dr Uzi Nur, who recognised the cryptic species diversity of *Ferrisia* mealybugs in the 1970s based on electrophoretic comparison of their enzymes. Nur referred to this species, which we name in his memory, by his code "FK".

Taxonomic notes. Dr Uzi Nur sent adult male specimens of this and other *Ferrisia* species to the late Dr John (Jack) W. Beardsley for study. Beardsley found morphological differences among the adult males of the samples that Nur identified as different species based on enzyme electrophoresis. For Nur's species FK (our *F. uzinuri*), Beardsley reported that the adult male was the most distinctive of all of the species, being distinctly smaller, with relatively short antennae, and short setae on the legs and antennae (J.W. Beardsley, in letter to U. Nur, 9 March 1979). In further correspondence Nur noted that his species FK was so far known only from Florida and that live females "look the least *virgata*-like, since they lack the characteristic dark body color and markings. In other respects such as body shape and glass-like long wax filaments, they are similar to the others. Moreover, in their enzymes they are also not much more dissimilar than most of the other species to one another." (U. Nur in letter to J.W. Beardsley, 26 March 1979).

Ferrisia virgata (Cockerell)

(Figs 2G, 21)

Dactylopius virgatus Cockerell, 1893a: 178.
Dactylopius virgatus var. *farinosus* Cockerell, 1893a: 178. Synonymy by Ferris, 1950: 93.
Dactylopius virgatus var. *humilis* Cockerell, 1893a: 179. Synonymy by Ferris, 1950: 93.
Dactylopius segregatus Cockerell, 1893b: 254. Synonymy by Williams & Granara de Willink, 1992: 183.
Dactylopius ceriferus Newstead, 1894: 24. Synonymy by Cockerell, 1898: 240.
Dactylopius dasylirii Cockerell, 1896: 202. Incorrect synonymy by Ferris, 1953: 362. [Refer to the description of *F. dasylirii* for discussion of the revised status of this species.]
Dactylopius talini Green, 1896: 7. Synonymy by Cockerell, 1899: 391.
Dactylopius setosus Hempel, 1900: 386. Synonymy by Costa Lima, 1939: 3.
Pseudococcus virgatus; Kirkaldy, 1902: 103. Change of combination.
Dactylopius magnolicida King, 1902: 616. Synonymy by Williams & Granara de Willink, 1992: 183.
Dactylopius virgatus var. *madagascariensis* Newstead, 1908: 7. Synonymy by Mamet, 1951: 216.
Pseudococcus marchali Vayssière, 1912: 366. Synonymy by Ferris, 1950: 93.
Pseudococcus bicaudatus Keuchenius, 1915: 49. Synonymy by Green, 1916: 51.
Ferrisia virgata; Fullaway, 1923: 308. Change of combination.
Ferrisiana virgata; Takahashi, 1929: 429. Change of combination.
Ferrisia virgata; Morrison & Morrison, 1966: 78; McKenzie, 1967: 179. Change of combination.
Ferrisia neovirgata Khalid & Shafee, 1988: 71. Synonymy by Williams, 2004: 268.

For a full synonymy with details of type material and depositories, refer to Williams & Granara de Willink (1992), Williams (1996) or Ben-Dov (2012).

Type material: **lectotype** (here designated) of *Dactylopius virgatus* Cockerell: adult ♀ on slide with 4 other adult ♀♀ and 3 nymphs (mostly in poor condition), lectotype farthest from original label and clearly indicated, slide label: "Dactylopius / virgatus / Ckll. / Part of type / from Jamaica. / 7"(USNM). **Paralectotypes:** 4 adult ♀♀, 1 second-instar nymph & 2 first-instar nymphs, on same slide as lectotype (USNM); 17 adult ♀♀ or part of, 1 pharate adult ♀ in cuticle of third instar, 2 adult males, several damaged nymphs (distributed among 3 slides), one slide with 2 labels: "*Dactylopius* / *virgatus*, Ckll MS / BM / On ? 1945, 121 / Kingston Jamaica / 1892. T.D.A. Ckll. col." and "No 105 / B.iv, p. 85 / Type lot / R. Newstead" and other 2 slides with "*Dactylopius* / *virgatus*, Ckll / Type lot. Ex coll Ckll Jamaica / Institute / RN. BM 1945,121" or similar (BMNH).

Other material from Cockerell (non-type): 2 adult ♀♀ in poor condition (1 slide), with label: "Pseudococcus virgatus / (Ckll) / Type / East St. Kingston, Jamaica / Re'ed fr. Ckll. Jan 3, 1984 / 5636" (USNM); 4 adult ♀♀ (4 slides) slide-mounted by P.J. Gullan 2002 from dry material in box with two labels inside: "Ckll. Coccidae III. TYPE. / *Dactylopius virgatus*, Ckll. / East St. Kingston. Jamaica" and "5636 from Cockerell / Jan 3.94" [latter label in pencil and in different handwriting to main data label] (USNM); 6 adult ♀♀ in poor condition (1 slide), with label: Pseudococcus virgatus / (Ckll) / On Guava / Kingston, Jamaica / Ckll. / May 3, 1983 5636" (USNM).

The USNM has a number of specimens of *F. virgata* sent from Jamaica by T.D.A. Cockerell, including one slide with a number of specimens that we regard as part of Cockerell's original collection and from which we designate a lectotype (see above). In addition, there are other specimens sent from Jamaica by Cockerell but these are dated 1893 and 1894, whereas the orginal collection was made in 1892 and the species was described in 1893. Although one of these subsequent collections bears the label "Type", we do not regard these specimens as types since it is clear that they were sent from Jamaica as live specimens in 1894 (as ascertained from notes by Theodore Pergande housed in the Coccoidea collection at SEL). The other subsequent collection was received in May 1893 but the host plant was guava, and this host was not mentioned in Cockerell's original description of the species. Williams & Granara de Willink (1992) and Williams (1996) discussed syntype material in the BMNH apparently sent by Cockerell to R. Newstead for his opinion. A list of "Coccidae" sent from Cockerell to Newstead in May 1892 and a letter from Cockerell to Newstead dated May 28th 1892 (both held in the BME) show that Newstead was sent specimens of Cockerell's "*Dactylopius virgatus*" from East Street, Kingston, Jamaica, in 1892, together with notes on the live appearance of the mealybug and the comment: "A very destructive species; on a very glutinous tree with fleshy leaves and long spines". We have been unable to establish a possible identity for this host plant. Some specimens in the BMNH are labelled: "Dactylopius virgatus Ckll., Type lot, ex coll. Ckll. Jamaica Institute" and others "Dactylopius virgatus Ckll., M.S. On ? Kingston, Jamaica 17892, T.D.A. Ckll. ? Type lot". We regard these specimens as paralectotypes and have listed them above.

Cockerell's original (1893a: 178) description of this species is accompanied by the comment that the mealybugs were in enormous numbers on an unidentified tree in East Street, Kingston, with the tree referred to as follows: "The leaves are ovate-acuminate, fleshy, entire; stalks reddish, with some long spines, very glutinous". In the same paper, Cockerell (1893a) described four varieties of his *Dactylopius virgatus* from Kingston and named two of these varieties, namely *D. virgata* var. *farinosus* from *Prosopis juliflora* (Fabaceae) and *D. virgatus* var. *humilis* from *Tribulus cistoides* (Zygophyllaceae). One of the unnamed varieties was collected from *Acalypha* (Euphorbiaceae), which we know to still be a host of *F. virgata* in Kingston, and the other from *Annona* (sweetsop) (Annonaceae). The latter collection may have been *F. dasylirii*, given that we have a large recent collection of *F. dasylirii* from this host at the same locality in Kingston. These four varieties apparently differed mainly in the amount and patterns of the wax and bare areas of the dorsum, but there are no museum specimens identified as these varieties and their taxonomic status cannot be assessed. Cockerell (1893b) also listed another species, *D. segregatus* Cockerell, on grass in East Street, Kingston, but the type material appears to be lost and so it is not possible to determine its identity, especially as *F. dasylirii* also is known to occur in Jamaica; see Williams & Granara de Willink (1992) for further discussion.

Ferris (1950) synonymised *Pseudococcus marchali* Vayssière with *Dactylopius virgata*. The types of *P. marchali* were collected from mango in Kouroussa, the Republic of Guinea (specifically in Haute-Guinee); a lectotype was designated by Williams (1996) from slide-mounted females in the MNHN. We examined the lectotype and one paralectotype (on the same slide) and both are adult females of *F. virgata*.

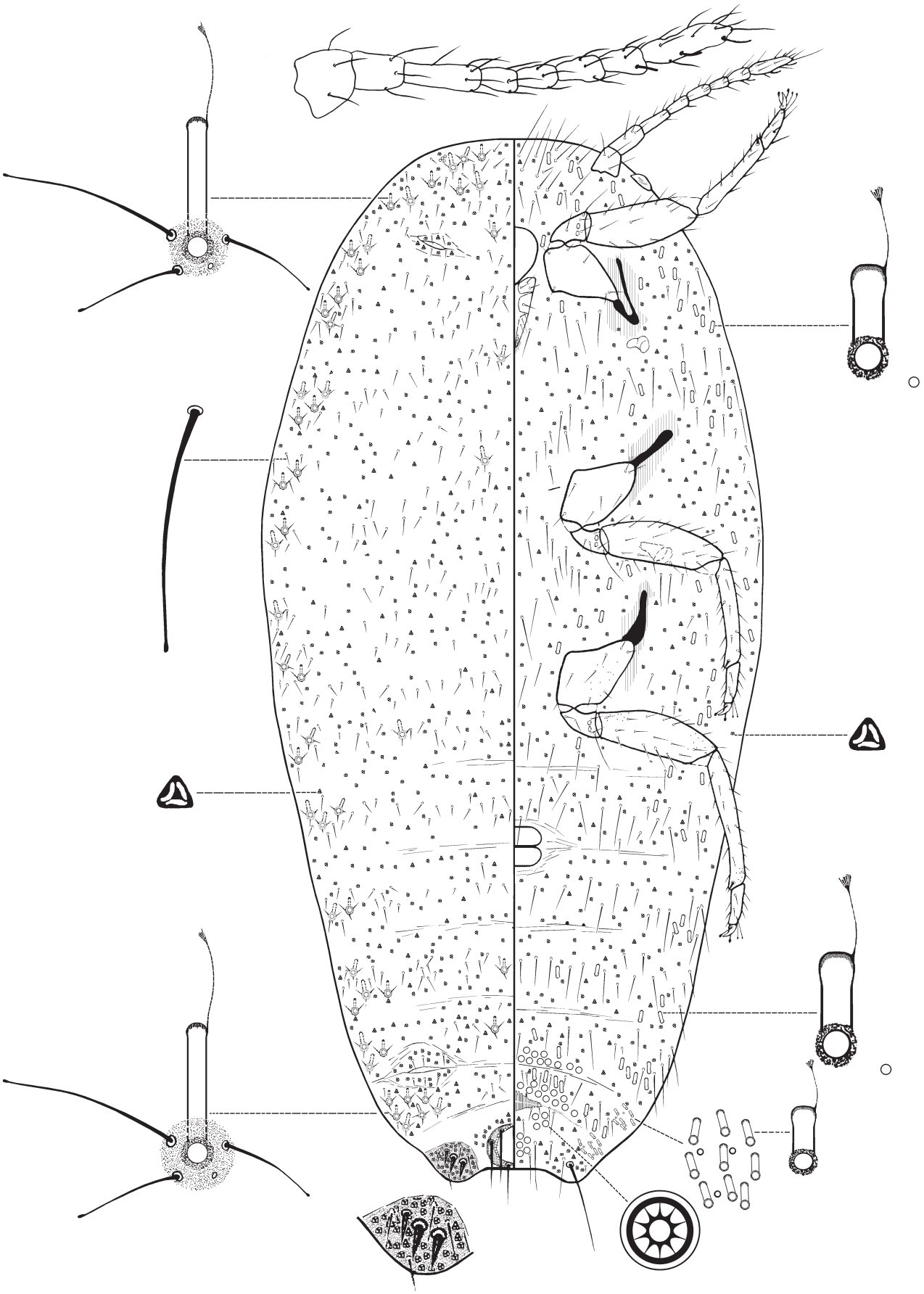

FIGURE 21. Adult female of *Ferrisia virgata* (Cockerell).

We were able to examine type specimens of *Dactylopius ceriferus* Newstead from India, *Dactylopius talini* Green from Sri Lanka, and *Dactylopius virgatus* var. *madagascariensis* Newstead (all housed in BMNH) and these adult females were all *F. virgata*. Williams & Watson (1988) designated a lectotype for *D. ceriferus* and for *D. talini*, but not for *D. virgatus* var. *madagascariensis*, presumably because most of the syntypes of the latter species are in the Museum für Naturkunde der Humboldt-Universität zu Berlin, Germany (Williams 1996).

We were unable to examine type material of *Dactylopius setosus* Hempel from Brazil, but the original description says that the antennae are 0.6–0.7 mm (600–700 mm) long, which is longer than typical for the adult females of *F. virgata*. Thus Hempel's species may be *F. dasylirii*, which also occurs in Brazil, and if so, *D. setosus* would be a junior synonym of *D. dasylirii*. Also we have not seen original material of *Ferrisia neovirgata* Khalid & Shafee from India, but because this species probably was described from immature specimens (Williams 1996), it would be difficult to allocate to species in any case. In addition, the types of *D. magnolicida* from Brazil, *D. segregatus* Cockerell from Jamaica, and *Pseudococcus bicaudatus* Keuchenius from Java are probably lost (Williams & Granara de Willink 1992; Williams, 1996) and thus it may never be possible to determine the species status of these names. Although it is possible that one or more of the above names represents a senior synonym of one the new species that we are recognising here, without type specimens it is impossible from the original descriptions to establish the identity of these species.

Other material examined and used for decription. 1 adult ♀, ex unidentified ornamental plant, BRAZIL, Espírito Santo, Vítoria, INCAPER library, 6.iv.2005, M. Culik (BME); 9 adult ♀♀ (9 slides, including DNA voucher FBK005), ex *Acacia* sp. on seed pod, GHANA, Greater Accra region, Shai Hills Resource Reserve, 05° 53'N, 00°03'E, 75 m, 12. vi. 2005, T. Kondo (BME); 4 adult ♀♀ (4 slides, including DNA voucher LGC01078), ex *Acalypha wilkesiana* on foliage, JAMAICA, Kingston, East Street, 7. ix. 2003, T. Kondo (BME); 13 adult ♀♀ (13 slides, including DNA voucher TK0461), ex *Coccoloba uvifera* (Polygonaceae), MEXICO, Guerrero (state), Acapulco, near Fiesta Inn Hotel, 16°51'N, 99°51'W, 5 m, 16.i.2007, T. Kondo (BME); 8 adult ♀♀ (8 slides, including DNA voucher FBK004), ex culture of sprouted potato, SOUTH AFRICA, Stellenboch, 1. i. 2002, W. Wakgari (orginally from an exotic ornamental, *Cestrum aurantiacum* in 2000, reared in culture at CRI) (BME); 7 adult ♀♀ (7 slides, including DNA voucher NH164), ex *Acalypha wilkesiana*, THAILAND, Nakhon Pathom, Kasetsart Univ. Kampaengsaen campus, 14°02'S, 99°58'E, 17 m, 1. vi. 2007, T. Kondo (BME).

Ferrisia virgata is more widely distributed than any other species of the genus. In addition to the above list, we examined, but did not measure, specimens of *F. virgata* from the following countries: Australia, Brazil, Cambodia, China, India, Indonesia (Sumba - Lesser Sunda Islands), Kenya, Malaysia, Philippines, Singapore, Tahiti, Uganda, USA (Hawai'i) and Zambia, on the following plant species: *Acalypha* sp. (Euphorbiaceae), *Amaranthus* sp. (Amaranthaceae), *Annona muricata, A. squamosa* and *A. reticulata* (Annonaceae), *Calophyllum inophyllum* (Calophyllaceae), *Carica papaya* (Caricaceae), *Citrus* sp. (Rutaceae), *Codiaeum* sp. (Euphorbiaceae), *Coffea* sp. (Rubiaceae), *Gardenia* sp., (Rubiaceae), *Hibiscus* sp. (Malvaceae), *Hoya* sp. (Apocynaceae), *Indigofera* sp. (Fabaceae), *Leucaena* sp. (Fabaceae), *Mangifera indica* (Anacardiaceae), *Morus* sp. (Moraceae), *Pisonia* sp. (Nyctaginaceae), *Psidium guajava* (Myrtaceae) and *Rhipsalis baccifera* (Cactaceae). The above host-plant list is not comprehensive as *F. virgata* is polyphagous and can feed on numerous plant species. It occurs widely in Central and South America (see below under "Biological notes"), but we have not made detailed lists of localities and host plants from this region.

The native range of *F. virgata* is unknown and it is possible that Jamaica is not part of the natural distribution of this species because, when it was described, Cockerell (1893a) referred to this mealybug as a destructive species and reported it on a number of hosts in Kingston, Jamaica. Thus *F. virgata* might have been introduced to Jamaica, where it became a pest; however, this mealybug still occurs at the type locality in Jamaica as it was collected there on *Acalypha wilkesiana* in 2003. See "Biological notes" below for further discussion.

ADULT FEMALE. Diagnosis. *Ferrisia virgata* can be diagnosed by the following combination of features: presence of clusters of small oral-collar tubular ducts on ventral margins of last 2 or 3 abdominal segments; ventral oral-collar tubular ducts frequently associated with a minute discoidal pore which rarely touches rim of duct, usually distant from rim by at least half length of duct; dorsal enlarged tubular ducts totalling 69–101 throughout dorsum, sclerotised area around rim of each duct often with 1 or 2 oval discoidal pores usually not touching outer margin of sclerotised area and almost never projecting out from margin; multilocular disc-pores on venter of abdominal segments VI (11–28) (usually more than 15 in double row), VII (22–41) and VIII + IX (14–29); anal lobe cerarii each with 2–3 (generally 3) conical setae; both pairs of ostioles present; antennae usually ≤600 μm long; hind coxa with translucent pores.

Ferrisia virgata is most similar to *F. dasylirii* as both species have more than one size of ventral oral-collar tubular ducts, with clusters of small oral-collar tubular ducts on the ventral margins of the last 2–3 abdominal segments, and a minute discoidal pore usually near rim of each enlarged dorsal tubular duct and most ventral oral-collar tubular ducts but never touching the rim of the duct opening. *F. virgata* can be distinguished readily from *F. dasylirii* by the following features: (i) discoidal pores associated with the sclerotised area around the rim of the dorsal enlarged tubular ducts (Fig. 4Aa) on the abdomen usually not touching the outer margin of the sclerotised area and almost never projecting out from margin (in *F. dasylirii* most discoidal pores are on the outer margin of the sclerotised area and often each pore and its surrounding sclerotisation projects out from the margin; Fig. 4Ab); (ii) small oral-collar tubular ducts in clusters on the posterior abdomen with distal end of each duct rounded (in *F. dasylirii* the distal end of each duct is slightly tapered towards the attachment of inner ductile); (iii) antennae usually ≤600 µm long with apical segment 105–125 µm long (usually ≥600 µm long with apical segment 120–150 µm (usually >125 µm) long in *F. dasylirii*); (iv) usually ≥15 multilocular disc pores on the venter of abdominal segment VI, typically forming at least a partial double row medially (in *F. dasylirii* usually ≤15 pores and typically forming a single, sometimes irregular, row); (v) translucent pores present on dorsal surface of hind coxa, especially posterolaterally, although often few in number (usually absent in *F. dasylirii*); (vi) one or both anal lobes sometimes with an extra 1–2 conical cerarian seta that are more slender than the other 2 setae (in *F. dasylirii* only 2 cerarian setae except some specimens from *Dasylirion*). *F. virgata* also is similar to *F. cristinae*, *F. kondoi* and *F. williamsi* (which all have at least two sizes of ventral oral-collar tubular ducts as well as clusters of small oral-collar tubular ducts on the ventral margins of the last 2–3 abdominal segments). However, *F. virgata* can be readily distinguished from the other three species by the position of the minute discoidal pores associated with ducts which, in *F. virgata*, are always near the enlarged tubular ducts and ventral oral-collar tubular ducts but never touch the rim of the duct opening (discoidal pores always adjacent to duct openings in *F. kondoi* and *F. williamsi,* and mostly adjacent in *F. cristinae*). *F. virgata* shows some similarity to *F. milleri* and *F. ecuadorensis* but can be separated easily from these two species by the absence of ventral marginal clusters of small oral-collar tubular ducts on the head, thorax and anterior abdominal segments (*F. milleri* has these clusters around the entire body whereas *F. ecuadorensis* has clusters on all abdominal segments).

Description of slide-mounted specimens (based on selected type material of *D virgatus* and other specimens listed above; Fig. 21). Body elongate oval, 2.10–4.48 mm long, 0.94–2.52 mm wide. Eye marginal, 50–75 µm wide. Antenna 8 segmented, 480–640 µm (generally ≤600 µm, often ≤560µm) long; apical segment 105–125 µm long, 30–35 µm wide. Clypeolabral shield 150–188 µm long, 135–200 µm wide. Labium 180–225 µm long, 90–130 µm wide. Anterior spiracles 60–85 µm long, 37–53 µm wide across atrium; posterior spiracles 70–113 µm long, 55–80 µm wide across atrium. Circulus quadrate, 115–195 µm wide, divided by an intersegmental line. Legs well developed; hind trochanter + femur 390–515 µm long, hind tibia + tarsus 410–530 µm long, hind claw 32–43 µm long. Ratio of lengths of hind tibia + tarsus to hind trochanter + femur 1.03–1.14, ratio of lengths of hind tibia to tarsus 2.68–3.25, ratio of length of hind trochanter + femur to greatest width of femur 3.73–5.25. Tarsal digitules subequal, each 50–60 µm long. Claw digitules subequal, each 35–43 µm long. Translucent pores present on hind legs, totalling 19–70 on coxa, femur and tibia combined; with 10–30 on dorsal surface of each hind coxa. Ostioles: both pairs present; each anterior ostiole poorly developed, with 22–28 trilocular pores and 7–11 setae; each posterior ostiole with 41–49 trilocular pores and 11–14 setae. Anal ring 120–195 µm wide, with 6 anal ring setae, each seta 170–235 µm long.

Dorsum. Anal lobe cerarii each with 2 conical setae, 37–43 µm long (sometimes an additional 1–2 robust setae, 20–36 µm long, slightly thinner than typical conical cerarian setae), with 36–60 trilocular pores and 4–6 auxiliary setae. Dorsal body setae slender, each 15–53 µm long. Trilocular pores each 4–5 µm in diameter. Enlarged tubular ducts totalling 69–122 on dorsum, each duct 30–35 µm long, 5.0–7.5 µm (generally 7.0–7.5 µm) wide at mid-length, rim of duct opening sclerotised, 10–13 µm wide, surrounded by a sclerotised circular area 15–35 µm wide, usually enclosing 1 or 2 oval discoidal pores (not touching outer margin of sclerotised area and almost never projecting out from margin) and with 1–5 (generally 2 or 3) setae, each 12–35 µm long, usually either within sclerotised area (especially on abdomen) or on edge of sclerotised area (especially on head); ducts distributed marginally in clusters of 2–6 on head and thorax, on margins of all abdominal segments in groups of 1–4, but with 5–9 ducts on each side of abdominal segment VII, and also 3–7 medially to submarginally on head and thorax, 5–10 medially to submedially on abdominal segments.

Venter. Body setae slender, each 12–197 μm long, longest setae medially on head; apical setae of anal lobe 280–325 μm long. Multilocular disc pores present on posterior abdominal segments only: 11–28 pores on segment VI (usually more than 15 and in at least partial double row), 19–41 on segment VII, 14–29 on segments VIII + IX; each pore 7–11 μm in diameter. Trilocular pores each 3–4 μm in diameter. Minute discodial pores each 2.0–2.5 μm in diameter, almost always associated with oral-collar tubular ducts, but never touching rim of ducts. Oral-collar tubular ducts on most of venter (excluding margins of posterior abdomen) each 10–13 μm long, 2.5–4 μm wide, totalling 53–95, distributed as follows: 33–43 on head and thorax, and on abdominal segments: 14–19 total on segments I–III; 4–7 on IV; 4–11 on V; 7–16 on VI; 8–18 on VII; none on VIII. Small oral-collar tubular ducts each 7.0–9.0 μm long, 3–4 μm wide, distributed as follows on margin of abdominal segments: 0–2 on each side of VI; 3–9 on each side of VII; 2–9 on each side of VIII.

Biological notes. The first description of *F. virgata* (Cockerell 1893a) records this mealybug as numerous on a range of host plants in Jamaica. Shortly afterwards, this mealybug was described (under several different names) from India (Newstead 1894), Sri Lanka (Green 1896), Madagascar (Newstead 1908), West Africa (Vayssière 1912) and Java (Keuchenius 1915). This pattern of spread and abundance at new localities is typical for newly invading insect species (Liebhold & Tobin 2008) and suggests that *F. virgata* was carried around the world within about 10 years of its first discovery in Jamaica. However, the high abundance of *F. virgata* in Jamaica in 1892 suggests that it was not native to that island. It occurs throughout Central and South America (Williams & Granara de Willink 1992; Culik *et al*. 2006; Kondo *et al*. 2008) and may be the species described as *Dactylopius setosus* by Hempel (1900) at the very beginning of his publishing career (however *F. dasylirii* also occurs in Brazil).

With the exception of records of *F. malvastra*, all other reports of *Ferrisia* from outside of the Nearctic and Neotropical regions are of *F. virgata*. Thus descriptions of immature stages (Awadallah *et al*. 1979a; Paul & Ghose 1989) and studies of the biology (e.g., Ghose & Paul 1972; Awadallah *et al*. 1979b) of *F. virgata* in Egypt and India probably do refer to this species. *Ferrisia virgata* has been reported widely as a destructive pest on ornamental plants in India (reviewed by Ghose & Paul 1972). Awadallah *et al.* (1979b) found that *F. virgata* produced five generations per year if maintained on sprouting potato tubers at temperatures ranging from 16–29°C and 54–71% RH. These authors reported production of males if the mealybugs were maintained at high density on either potato sprouts or on *Acalypha* foliage, and claimed the occurrence of parthenogenetic reproduction for females maintained singly (but not isolated). Parthenogenesis is highly unlikely, especially as Ghose & Paul (1972) found that isolated virgin females did not produce any eggs. Adult females do not produce a definite ovisac but rest upon a pad of cottony white filaments on which they deposit eggs (Fig. 2G). *Ferrisia virgata* is clearly ovoviparous because eggs hatch usually within 30 minutes of being laid (Ghose & Paul 1972). Fecundity per adult female has been reported as 64–78 eggs (Awadallah *et al*. 1979b) to 222–737 eggs (Ghose & Paul 1972) under similar rearing conditions in the laboratory. In nature, the lower surface of leaves and the junction of the petiole with the stem were preferred oviposition sites on its main host plant in Egypt, *A. macrophylla* [this may refer to the cultivar *A. wilkesiana* "macrophylla'] (Awadallah *et al*. 1979b). Three species of parasitoid wasps, *Leptomastix* sp. (Encrytidae) and two *Tetrastichus* spp. (Eulophidae), three species of Coccinellidae and two species of Neuroptera were reported as natural enemies in Egypt (Awadallah *et al*. 1979b), although numbers were low relative to the high numbers of mealybugs. In India, Ghose & Paul (1972) recorded only a coccinellid predator (*Scymnus* sp.), of which the larvae were effective at controlling a population of the mealybug in culture. *Ferrisia virgata* is polyphagous, although *Acalypha* appears to be a favoured host plant in many countries, based on data from collections that we have examined for this revision.

Ferrisia virgata has been reported to transmit swollen shoot virus (CSSV) in cacao (Thresh & Tinsley 1959; Roivainen 1976; Thorold 1975; ICTVdB Management 2006) and citrus tristeza virus (reported as lime dieback) on *Citrus aurantifolia* in Ghana (Hughes & Lister 1953). In Africa, *F. virgata* has been shown to prefer cocoa leaf and reproductive parts (flowers and pods) to stem tissue, and although it has been reported to produce honeydew, it is rarely ant attended (Entwistle 1972), probably because its stylets reach the phloem infrequently (Entwhistle & Longworth 1963).

***Ferrisia williamsi* Kaydan & Gullan sp. n.**
(Figs 2H, 22)
urn:lsid:zoobank.org:act:84AB7D42-7FB6-4660-B919-3D5FD9B604AD

Type material: Holotype adult ♀, ex bract of inflorescence of *Heliconia* sp., COLOMBIA, Quindio, Parque Nacional del Café, 30.xii.2004, T. Kondo, UCDC type # 1792 (BME).

Paratypes: 4 adult ♀♀ (4 slides, including DNA voucher NH163), same data as holotype (BME); 5 adult ♀♀ (5 slides), ex stem of avocado, *Persea americana*, COLOMBIA, Valle del Cauca, Alcalá, Hacienda la Polonia, 04°17'59"N, 75°53'08"W, 1361 m, 4.xi. 2008, T. Kondo (1 slide ANIC, 3 BME, 1 UNCB); 8 adult ♀♀ (8 slides) ex leaves of *Pithecellobium dulce*, COLOMBIA, Valle del Cauca, Palmira, Cali, International Airport, 03°33'N, 76°23'W, 1017 m, 2.x. 2008, T. Kondo (1 slide ANIC, 5 BME, 1 UNCB, 1 USNM); 12 adult ♀♀ (12 slides, including DNA voucher TK0657) ex trunk of *Erythrina* sp., COLOMBIA, Antioquia, Medellin, at bus terminal, 06°12'49"N, 75°35'15"W, 18.ix. 2008 and 29.vii.2009, T. Kondo (1 slide ANIC, 8 BME, 3 UNCB); 41 adult ♀♀ & 1 third-instar ♀ (42 slides) ex foliage of *Inga edulis*, COLOMBIA, Valle del Cauca, Cali, 03°28'25"N, 76°31'12"W, 1017 m, 8.xii. 2008, T. Kondo (4 slides ANIC, 22 slides BME, 2 BMNH, 2 CSCA, 3 IMLA, 3 USNM, 6 UNCB).

Other material examined (may not be conspecific with Colombian specimens and measurements not included in the description below): 2 adult ♀♀ (2 slides), ex orchid leaf, BOLIVIA, intercepted Miami 12577, 5.i.1976, E.B. Lee (USNM); 1 adult ♀, ex *Croton* (*Codiaeum*), BRAZIL, Rio de Janeiro, 23.x.1935, D.T. Fullaway, 37 339 (USNM); 1 adult ♀, ex orchid leaf, BRAZIL, intercepted Miami 5740, 14.v.1973, J.L. Buff (USNM); 2 adult ♀♀ (2 slides), ex *Spondias purpurea*, COSTA RICA, San Jose, La Sabana airport, 5.ii.1970, M. Kosztarab, Herb C446a&b (USNM); 3 adult ♀♀ (1 slide), ex *Codiaeum variegatum*, COSTA RICA, San Pedro de Montes de Oca, 14.x.1932, C.H. Ballou, C.R.618, 32 1823 (USNM); 2 adult ♀♀ (1 slide), ex *Annona reticulata* fruit, GUYANA, intercepted JFK [New York], 14.ix.1981, B. Isaksoa, JFKIA 35931 (USNM); 1 adult ♀, ex *Codiaeum*, NICARAGUA, intercepted at Philadelphia, 22.vi.1932, A.B. Wells, Phila#15385, 32 1374 (USNM); 1 adult ♀, ex orchid leaf, PERU, intercepted at Miami, 14.xi.1960, C.R. Shepard, Miami 14908, 61 0435 (USNM); 1 adult ♀, ex ornamental cut greens, USA, Florida via Texas [may come from Mexico], intercepted California, Blythe Inspection Station, 23.iii.2010, coll. Burries, PDR#50003722 (CSCA).

There is some variation among specimens of this species from different collections in Colombia and also there are specimens of uncertain identity from other places (listed immediately above) that have similarity to *F. williamsi*. Thus, although we have examined material from a number of Neotropical countries, we deliberately restrict the type series to material collected recently in Colombia and represented by several specimens per collection. Further taxonomic study based on both morphological and molecular data is warranted.

ADULT FEMALE. Diagnosis. *Ferrisia williamsi* can be diagnosed by the following combination of features (based on type females only): presence of a few (0–10, usually ≤6, per segment) small oral-collar tubular ducts usually scattered or clustered on ventral margins of last 2–3 abdominal segments; ventral oral-collar tubular ducts with/without 1–2 minute discoidal pores, a few with 2 contiguous elliptical to elongate triangular pores touching rim of duct opening (if with discoidal pores, duct opening in slightly sclerotised area); dorsal enlarged tubular ducts totalling 100–120 throughout dorsum, with 1 or 2 circular to oval discoidal pores usually adjacent to rim of each duct opening and at least a few adjacent as a double pore; number of multilocular disc-pores on venter of abdominal segments as follows: segment VI (2–5), VII (12–16), and VIII + IX (12–21); anal lobe cerarii each with 2 conical setae; both pairs of ostioles present and pairs well developed; translucent pores scattered on dorsal surface of hind coxa.

Adult females of *F. williamsi* from Colombia are most similar to *F. cristinae* from Argentina and the two species are difficult to distinguish morphologically, but in *F. williamsi* any minute discoidal pores associated with the ventral oral-collar ducts always touch the rim of duct opening and are larger than those in *F. cristinae* (in *F. cristinae*, discoidal pores associated with ventral ducts often do not touch the duct rim); furthermore, the translucent pores on the hind coxa of *F. williamsi* are mostly 2.0–3.0 µm in diameter (mostly 0.5–2.0 µm in *F. cristinae*). *F. williamsi* differs from *F. kondoi* by having scattered translucent pores on the hind coxa (none on the coxa of *F. kondoi*), fewer trilocular pores on each anal lobe (36–50 in *F. williamsi*; 58–62 in *F. kondoi*), and usually fewer small oral-collar tubular ducts in each cluster on the ventral margins of the posterior abdominal segments with mostly ≤6 on each side of each of segments VII and VIII (6–25 on each side of VII and 8–21 on each side of VIII in *F. kondoi*). The adult female of *F. williamsi* differs from that of *F. virgata* in the position of the discoidal pores, having 1 or 2 pores adjacent

to the opening of most dorsal enlarged ducts and ventral oral-collar tubular ducts (discoidal pores never adjacent to duct openings in *F. virgata*). *F. williamsi* can be separated from *F. milleri* and *F. ecuadorensis* by the absence of clusters of small oral-collar tubular ducts on the head, thorax and anterior abdominal segments (clusters present on all body segments in *F. milleri* and all abdominal segments in *F. ecuadorensis*).

The live mature adult female of *F. williamsi* from Colombia has a distinctive dorsal pattern of wax (Fig. 2H) that readily distinguishes it from the females of other species for which the live appearance is known.

Description of slide-mounted specimens (based on 36 type specimens, including holotype; Fig. 22). Body 1.80–3.77 mm long (holotype 2.30 mm), 0.85–2.28 mm wide (holotype 1.20 mm). Eye marginal, 65–85 µm wide. Antenna 8 segmented, 530–760 (mostly ≥600) µm long; apical segment 100–135 µm long, 30–35 µm wide. Clypeolabral shield 165–200 µm long, 170–190 µm wide. Labium 190–225 µm long, 100–130 µm wide. Anterior spiracles 65–85 µm long, 45–60 µm wide across atrium; posterior spiracles 80–100 µm long, 60–85 µm wide across atrium. Circulus quadrate, 160–280 µm wide, divided by an intersegmental line. Legs well developed; hind trochanter + femur 480–520 µm long, hind tibia + tarsus 480–600 µm long, hind claw 30–45 µm long. Ratio of lengths of hind tibia + tarsus to hind trochanter + femur 0.92–1.16, ratio of lengths of hind tibia to tarsus 2.93–3.67, ratio of length of hind trochanter + femur to greatest width of femur 4.16–5.66. Tarsal digitules subequal, each 40–60 µm long. Claw digitules subequal, each 35–40 µm long. Translucent pores present on hind coxa, femur and tibia, totalling 85–275 combined; usually with 25–70 (rarely up to 220), each 1.5–2.5 µm in diameter, on each hind coxa. Ostioles: both pairs present; each anterior ostiole poorly developed, with 30–40 trilocular pores and 6–8 setae; each posterior ostiole with 40–65 trilocular pores and 8–12 setae. Anal ring 110–155 µm wide, with 6 anal ring setae, each seta 220–300 µm long.

Dorsum. Anal lobe cerarii each with 2 conical setae, 25–40 µm long, with 36–50 trilocular pores and 2 or 3 auxiliary setae. Dorsal body setae slender, each 12.5–50 µm long. Trilocular pores each 4–5 µm in diameter. Enlarged tubular ducts totalling 100–120 on dorsum, each duct 30–38 µm long, 5.0–6.0 µm wide at mid-length, rim of duct opening sclerotised, 7.0–8.0 µm wide, surrounded by a sclerotised circular area 15–35 µm wide, enclosing 0–2 circular to oval discoidal pores (each generally adjacent to duct opening and sometimes 2 adjacent to each other) and with 2–5 (generally 2–4) setae, each 20–35 µm long, usually adjacent to duct rim within sclerotised area (especially on abdomen) or on edge of circular sclerotised area (especially on head); ducts distributed marginally in clusters of 2–5 on head and thorax, on margins of all abdominal segments in groups of 2–4, but with 7–9 ducts on each side of abdominal segment VII, and also 1–2 medially to submarginally on head and thorax, 0–2 medially on each abdominal segment.

Venter. Body setae slender, each 15–250 µm long, longest setae medially on head; apical seta of anal lobe approximately 315–350 µm long. Multilocular disc pores present on posterior abdominal segments only: 2–16 pores on segment VI, 12–33 on segment VII, 12–33 on segments VIII + IX; each pore 8–10 µm in diameter. Trilocular pores each 3–5 µm in diameter. Minute discodial pores (those not associated with oral-collar tubular ducts), each 2.0–2.5 µm in diameter, very few (no more than 2–4 per segment), generally on abdominal segments VI and VII; other discoidal pores associated with oral-collar tubular ducts generally elliptical to elongate triangular, with 1 or usually 2 contiguous pores touching rim of some oral-collar tubular ducts, each pore 2.5–4.0 µm in greatest width. Oral-collar tubular ducts on most of venter (excluding margins of posterior abdomen) each 7.5–11 µm long, 3–4 µm wide, totalling 45–100, distributed as follows: 16–40 on head and thorax, and on abdominal segments: 3–7 total on segments I–III; 2–5 on IV; 1–5 on V; 6–25 on VI; 10–24 on VII; usually 0 on VIII. Small oral-collar tubular ducts each 5.0–7.0 µm long, 3.0–4.0 µm wide, distributed on margins of abdominal segments as follows: 0–2 on each side of segment VI; 0–9 (mostly ≤6) on each side of VII; 0–10 (mostly ≤6) on each side of VIII.

Etymology. This species is named in honour of Dr Douglas J. Williams, who produced the last revision of *Ferrisa* (Williams 1996) and who is rightly regarded as the guru of world coccidology (Miller & Watson 1995) for his great knowledge and prodigious contributions to scale insect studies, as well as for the guidance that he has provided to others.

Biological notes. Type collections of *F. williamsi* are from hosts in the families Fabaceae, Heliconiaceae and Lauraceae, but the other possible records of this species are from Anacardiaceae, Annonaceae, Euphorbiaceae and Orchidaceae. The large collection of specimens from *Inga edulis* in Colombia had many associated larval coccinellids. The collection from *Pithecelobium dulce* in Colombia was mixed with specimens of *F. kondoi*. If the various specimens of uncertain identity (listed above) are *F. williamsi*, it seems that this species could easily be introduced to the USA because of the number of quarantine intercepts at ports of entry.

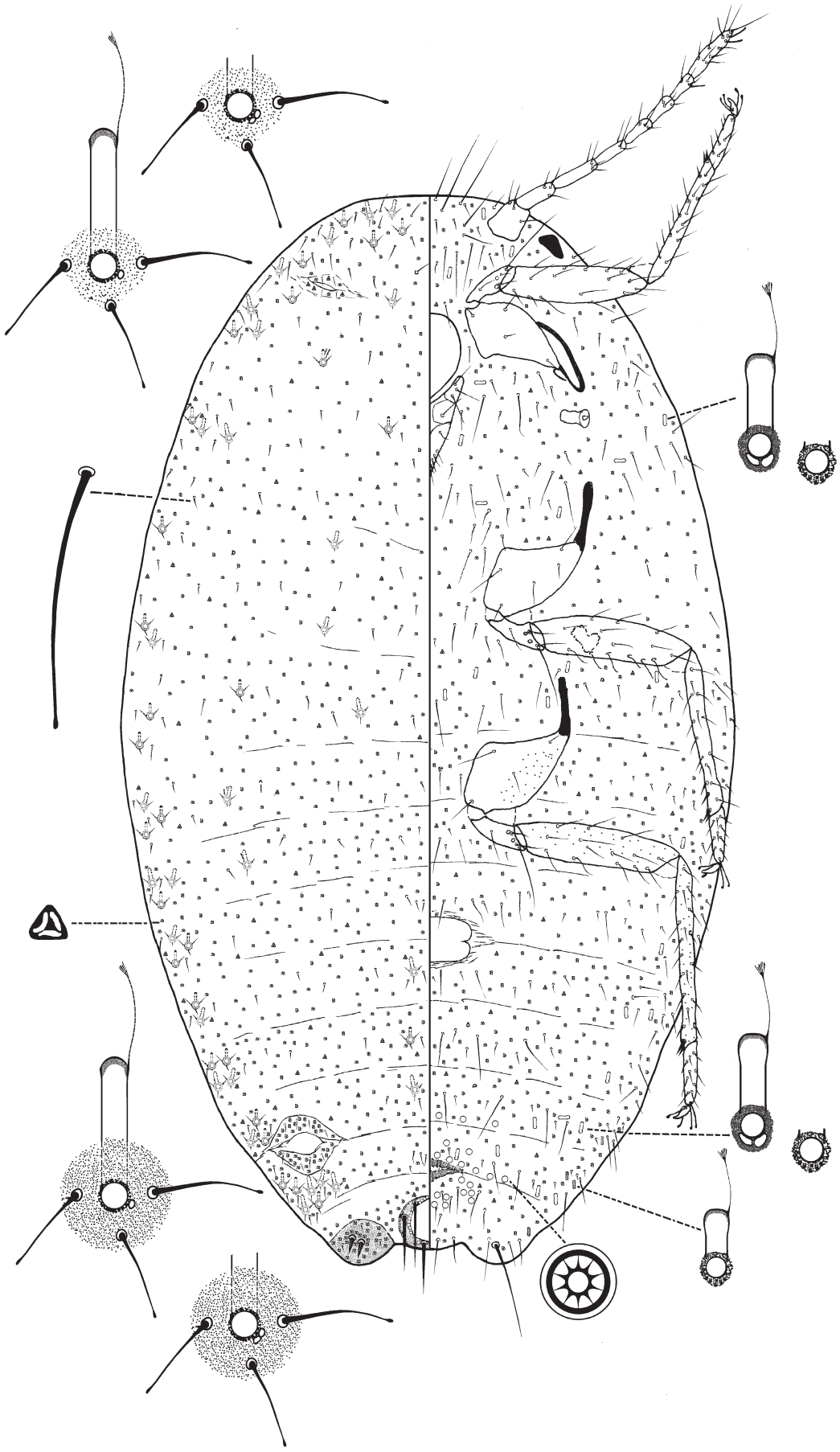

FIGURE 22. Adult female of *Ferrisia williamsi* Kaydan & Gullan sp. n.

Genus *Pseudoferrisia* Kaydan & Gullan gen. n.
urn:lsid:zoobank.org:act:F216908F-0204-4108-A657-35E5F5EA3B48

Type species: *Ferrisiana floridana* Ferris, by monotypy.

Ferris (1953) described and illustrated the adult female of an unusual species of mealybug from Florida, U.S.A., and placed it in the genus *Ferrisiana* Takahashi as *F. floridana* Ferris, along with four other species, *F. claviseta*, *F. quaintancii* (misspelt as *F. quaintancei*), *F. setosa* and *F. virgata*. McKenzie (1967) transferred these five species to *Ferrisia*. Although the adult female of *F. floridana* has enlarged tubular ducts on the dorsum, these ducts differ structurally from those of other *Ferrisia* species. The auxiliary setae around the sclerotised rim of the dorsal enlarged tubular ducts of *F. floridana* are short (mostly 8–15 μm long) and robust with a rounded apex, unlike the tapered and slightly capitate auxiliary setae (usually 15–40 μm long) found on other *Ferrisia* species. *F. floridana* also is distinctive in possessing six-segmented antennae (eight, rarely seven, segments in other species) and more than one pair of cerarii (all other *Ferrisia* species possess only anal lobe cerarii), plus some, slender cerarian-type setae more anteriorly on the abdominal margin and on the head. Also the anal lobe cerarii of *F. floridana* are unusual for *Ferrisia* in possessing numerous (usually 9–18; 15–16 on the holotype) long conical to lanceolate setae associated with a grouping of trilocular pores on the sclerotised area of each anal lobe. Although Ferris (1953) described the adult female as having three pairs of cerarii, only the anal lobe cerarius is always discrete with the cerarius of the penultimate and next most anterior segment sometimes being a diffuse group of lanceolate cerarian-type setae without obvious clustering of trilocular pores. The anal lobe cerarii of *F. floridana* more closely resemble those of species in the genus *Anisococcus* Ferris, which molecular data have shown to be closely related to *Ferrisia* (Downie & Gullan 2004; Hardy *et al.* 2008). The ventral surface of *F. floridana* is covered in oral-rim tubular ducts, with an orifice about the same diameter as a trilocular pore and a minute pore sometimes associated with the rim of the duct; these ducts are scattered on the head and thorax and in a transverse row on most abdominal segments. All other *Ferrisia* species lack ventral oral-rim tubular ducts. The dorsal setae (slender spine-like) and ventral setae (hair-like or spine-like) of *F. floridana* also differ structurally from the body setae (all bluntly tipped to capitate) on other *Ferrisia* species.

We were unable to obtain fresh material of *F. floridana* for our molecular phylogenetic study (Gullan *et al.* 2010) but, based on its morphology, we predict that *F. floridana* may be sister to all other *Ferrisia* species. The inclusion of *F. floridana* in *Ferrisia* makes the diagnosis of the latter genus unsatisfactory, with most features of *F. floridana* conflicting with those of other species, as discussed above. For this reason we here transfer *F. floridana* to a new monotypic genus, *Pseudoferrisia* gen. n., which we diagnose and describe below, followed by an illustrated redescription of the type species.

Generic diagnosis of adult female. The adult females of *Pseudoferrisia* can be distinguised readily from those of *Ferrisia* (features of the latter genus in parentheses) by having (i) numerous long conical to lanceolate cerarian setae on each anal lobe, with cerarii or partial cerarii present anterior to anal lobes (cerarii confined to anal lobes and cerarian setae rarely numbering more than 2 or 3 per cerarius); (ii) dorsal enlarged tubular ducts bearing slender spine-like setae on or near the sclerotised area around duct (tapered setae with a slightly capitate apex), (iii) short, slender spine-like dorsal setae with blunt apex (flagellate setae with a bluntly-tipped to slightly capitate apex), (iv) oral-rim tubular ducts present on venter and each sometimes associated with a minute discoidal pore (oral-rim tubular ducts absent on venter), (v) no circulus (circulus present), and (vi) antennae 6 segmented (8, rarely 7, segmented).

Generic description of adult female. Body elongate to oval, up to 4.7 mm long. Antennae 6 segmented. Labium 3 segmented, slightly longer than wide, apical segment broadly rounded at apex. Posterior pair of spiracles larger than anterior spiracles. Circulus absent. Legs well developed, with pit-like 'translucent' pores on hind coxa only; claw without a denticle; tarsal and claw digitules both capitate, claw digitules shorter and thicker than tarsal digitules. Anterior and posterior ostioles both present. Anal lobes well developed. Anal ring with 6 anal ring setae.

Dorsum. Cerarii present on posterior abdominal segments only; each anal lobe cerarius with up to 18 long conical to lanceolate setae associated with a group of trilocular pores on strongly sclerotised area of lobe; penultimate and sometimes more anterior cerarii present. Body setae slender, short (up to 13 μm long), spine-like with blunt apex, shorter than ventral setae. Trilocular pores each 4–5 μm in diameter, scattered over dorsum. Enlarged tubular ducts present, few in number, mostly marginal or submarginal; duct opening of each tubular duct surrounded by sclerotised rim and also a circular sclerotised area bearing 1–5 minute discoidal pores and associated with up to 7 slender spine-like setae. Oral-collar and oral-rim tubular ducts absent. Multilocular disc pores absent.

Venter. Body setae of two types, one robust hair-like with acute apex on mid venter, second type slender spine-like with acute apex in longitudinal row on submarginal area. Trilocular pores each 3–4 µm in diameter, scattered over surface. Minute discoidal pores scattered, almost always associated with ventral oral-rim tubular ducts. Oral-collar tubular ducts very few and only on posterior abdominal segments. Oral-rim tubular ducts scattered, some of them associated with a minute discoidal pore. Multilocular disc pores absent.

Etymology. The name reflects the similarity of this new genus to *Ferrisia*.

***Pseudoferrisia floridana* (Ferris) comb. n.**
(Fig. 23)

Ferrisiana floridana Ferris, 1953: 360.
Ferrisia floridana; McKenzie, 1967: 179. Change of combination.

Type material examined. **Holotype** of *Ferrisiana floridana Ferris*: adult ♀ on slide labelled: "Ferrisiana / floridana n. sp. / TYPE/ Host. Grass roots / Cross City, Fla. (7 ms. N.) / coll. T. H. Hubbell / Berlese funnel / -XI-1925 / 22756", UCD type # 640 (BME). Two paratypes could not be located.

Other material examined: U.S.A., Florida: 1 adult ♀, ex sedge, Columbia Co., Hwy 94, 16.vii.1983, R. Beshear (HHT-2-83) (FSCA); 1 adult ♀, ex grass roots, Cross City (7 ms. N.), xi.1925, T.H. Hubbell, Berlese funnel, 22756 (USNM); 1 adult ♀, ex sweeping, Dade Co., Everglades Nat. Park, E. entrance, 7.v.1975, R.F. Denno, J.A. Davidson, D.R. Miller, 2969 (USNM); 1 adult ♀, ex *Dichromena colorata* [now *Rhynchospora colorata*], Fellsmere, 13.ix.1982, E.W. Campbell (FSCA); 1 adult ♀, ex *Dichromena colorata*, Fellsmere, 20.ix.1982, E.W. Campbell (FSCA); 2 adult ♀♀ (2 slides), ex *Dichromena* sp., Fellsmere, 18.x.1982, E.W. Campbell (FSCA); 2 adult ♀♀ (2 slides), ex *Rhynchospora divergens*, Hobe Sound, 4.x.1978, E.W. Campbell (FSCA); 1 adult ♀, ex *Juncus effusus*, Palatka, 17.vii.1980, K. Elliott (FSCA); 2 adult ♀♀ (2 slides), ex *Rhynchospora* sp., Palm City, 12.ix.1978, E.W. Campbell (FSCA); 1adult ♀, ex *Veronica* sp., Palm City, 19.x.1978, E.W. Campbell (FSCA); 6 adult ♀♀ + 1 first-instar nymph (7 slides), ex *Bulbostylis ciliatifolia*, Port Saint Lucie, 13.xii.1977 and 25.xii.1977, E.W. Campbell (FSCA & USNM); 1 adult ♀, ex *Carex* sp., Port Saint Lucie, 3.vii.1977, E.W. Campbell (FSCA); 1 adult ♀, ex *Rhynchospora* sp., Port Saint Lucie, 12.v.1978, E.W. Campbell (FSCA); 3 adult ♀♀ (3 slides), ex sedge, Port Saint Lucie, 10.x.1989, A. Hamon, M. Williams et al. (FSCA); 2 adult ♀♀ (2 slides), ex *Bulbostylis* sp., Stuart, 13.v.1978, E.W. Campbell (FSCA); 1 adult ♀, ex *Rhynchospora* sp., Vero Beach, 21.xii.1982, E.W. Campbell (FSCA); U.S.A., Georgia: 1 adult ♀, ex unidentified grass, Charlton Co., 25.i.1975. R. Beshear (USNM).

This species is known only from grasses (Poaceae), rushes (Juncaceae), sedges (Cyperaceae) and shrubs in Florida and Georgia, U.S.A. The original description (Ferris 1953) records the species based on three females, one (explicitly specified as 'type') from the roots of an unidentified grass and two from the crop of a quail, both in Florida, but only the type specimen from Cross City, Florida, could be located in the BME where Ferris' collection is housed. There is one slide in the USNM with the same data as the holotype and, although the label says "original collection", this specimen is not referred to by Ferris (1953) and thus we do not consider it to have any type status. The USNM also has several other specimens from Florida collected either on grass roots, on the sedge *B. ciliatifolia*, or by sweeping vegetation, and one specimen from the adjoining state of Georgia. The FSCA has specimens from sedges, a rush and a shrub of *Veronica* (Plantaginaceae) and all collected in Florida. It is not known whether the mealybugs in the FSCA were found on the roots, crown or aerial parts of the plants.

Ferris (1953) described and illustrated the adult female, but we provide a revised description based on additional specimens as well as a new illustration (Fig. 23). Males of *P. floridana* have not been recorded but the USNM has one slide of a single first-instar nymph.

ADULT FEMALE. Diagnosis. As for genus.

Description of slide-mounted specimens (based on holotype and 10 other females: Fig. 23). Body elongate oval, 2.46–4.68 mm long (holotype 4.60 mm), 1.34–2.36 mm wide (holotype 2.25 mm). Eye marginal, 45–70 µm wide. Antenna 6 segmented, 290–380 µm long; apical segment 70–80 µm long, 30–33 µm wide. Clypeolabral shield 160–185 µm long, 170–185 µm wide. Labium 135–190 µm long, 110–180 µm wide. Anterior spiracles 65–90 µm long, 30–60 µm wide across atrium; posterior spiracles 80–100 µm long, 40–85 µm wide across atrium. Circulus absent. Legs well developed; hind trochanter + femur 270–360 µm long, hind tibia + tarsus 255–340 µm long,

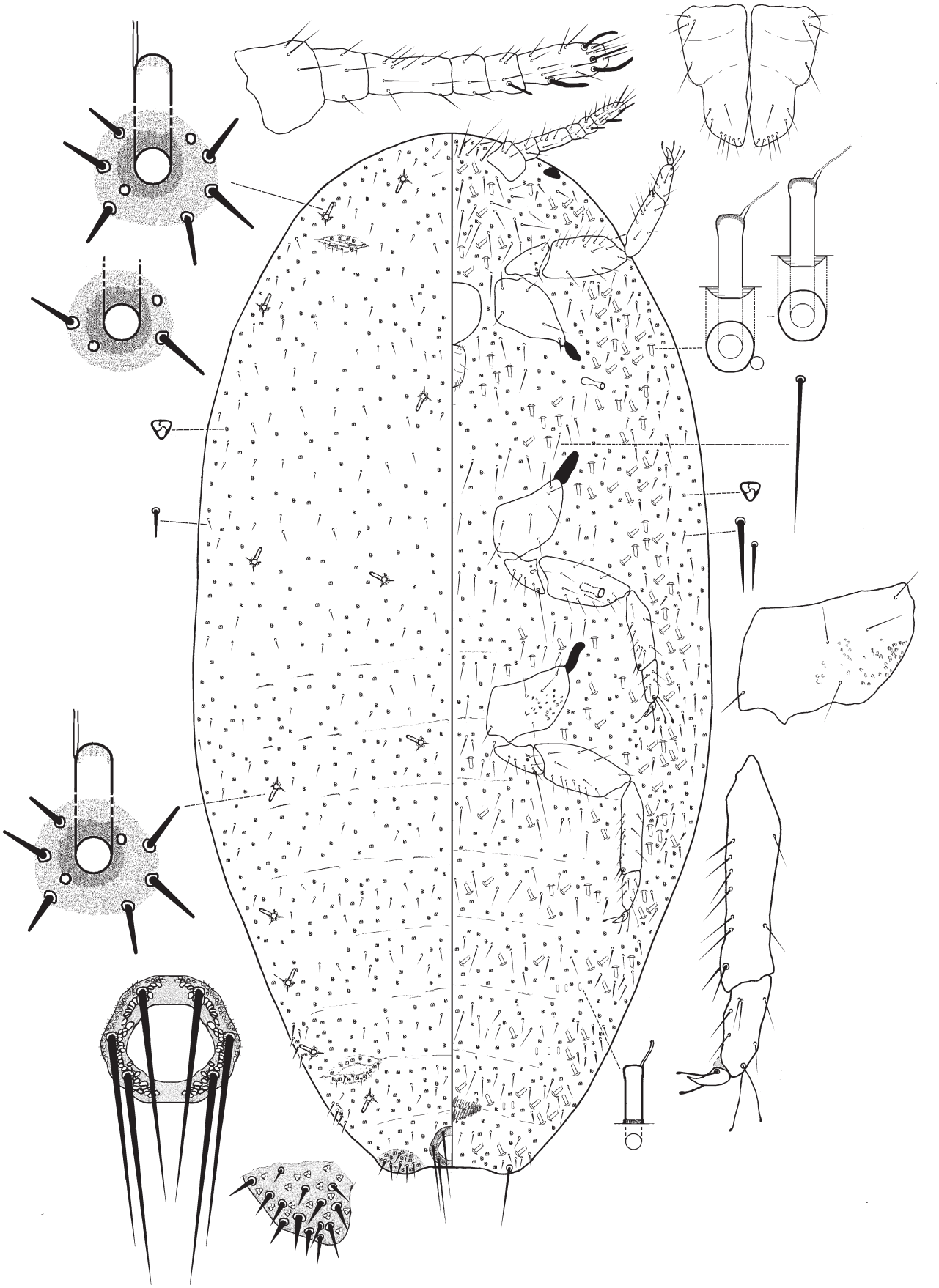

FIGURE 23. Adult female of *Pseudoferrisia floridana* (Ferris) comb. n.

hind claw 25–45 µm long. Ratio of lengths of hind tibia + tarsus to hind trochanter + femur 0.88–1.06; ratio of lengths of hind tibia to tarsus 1.84–2.40; ratio of length of hind trochanter + femur to greatest width of femur 3.05–5.20. Tarsal digitules subequal, each 40–57 µm long. Claw digitules subequal, each 25–40 µm long. Translucent pores present on hind coxa, mostly dorsal; on coxa totalling 16–30 pit-like 'pores'. Ostioles: both pairs present; each anterior ostiole, with 12–24 trilocular pores and 3–10 setae (setae on the posterior lips only); each posterior ostiole with 22–38 trilocular pores and 6–10 setae (setae on the posterior lips only). Anal ring 95–105 µm wide, with 6 anal ring setae, each seta 170–225 µm long.

Dorsum. Anal lobe cerarii present, each with 9–18 slender conical setae, 15–40 µm long, with 15–24 trilocular pores; penultimate cerarii (segment VII) each with 4–10 setae; cerarii on abdominal segment VI with 3–7 setae; sometimes scattered, slender cerarian-type setae present more anteriorly on abdominal margin and occasionally on head. Dorsal body setae short, each 7.5–12.5 µm long, and slender with blunt apex. Trilocular pores each 4–5 µm in diameter. Enlarged tubular ducts totalling 14–19 on dorsum, each duct 20–25 µm long, 7–10 µm wide at mid-length, rim of duct opening sclerotised, 7–10 µm in diameter, surrounded by a sclerotised circular area 17.5–25.0 µm wide enclosing 1–5 oval discoidal pores and associated with 2–7 (generally 3–4) blunt-tipped setae; if discoidal pores present within sclerotised area then position relative to duct opening variable; setae associated with ducts each 7.5–10 µm long, mostly within sclerotised area (in holotype), or just outside (in less mature specimens); ducts distributed mostly marginally to submarginally on head, thorax and abdominal segments, with 4–9 on head and thorax and 9–11 on abdominal segments II–VII usually with 1 or rarely 2 ducts on each side of each of these abdominal segments.

Venter. Body setae of two types: (i) robust hair-like setae with acute apex, each 10–150 µm long, longest setae present medially to submedially on head, thorax and abdomen; (ii) spine-like setae with acute apex, each 10–25 µm long, present in a longitudinal submarginal band. Apical seta of anal lobe 130–175 µm long. Multilocular disc pores absent. Trilocular pores each 3–4 µm in diameter. Discoidal pores each 2–3 µm in diameter scattered on ventral surface but generally associated with oral-rim tubular ducts. Oral-collar tubular ducts each 6–7 µm long, 3–4 µm wide at mid-length, ducts totalling 11–17, distributed on abdominal segments IV–VII as follows: 0–3 on IV, 3–6 on V, 4–6 on VI, 4–6 on VII. Oral-rim tubular ducts, each 10–12 µm long, 2.5–4.0 µm wide at mid-length, with outer rim 7–8 µm in diameter, sometimes associated with 1 discoidal pore, filament of duct short; ducts totalling 290–325, distributed as follows: 150–195 scattered on head and thorax, and in irregular transverse row on each of abdominal segments as follows: 63–119 on I–III, 22–24 on IV, 14–18 on V, 9–14 on VI, 11–16 on VII, and 5 or 6 on segment VIII.

Variation. The holotype is a very mature specimen (with embryos in the body) and has a larger body and longer appendages than the other specimens that we measured.

Acknowledgements

We dedicate this paper to Douglas J. Williams (The Natural History Museum, London) and the late Uzi Nur (formerly University of Rochester, New York, USA), whose earlier research on *Ferrisia* produced the foundation for our study. Dug Miller and Debra Creel (Systematic Entomology Laboratory, ARS, USDA, Beltsville, Maryland) kindly arranged loans of material from the Coccoidea collection at the USNM; Dug also counted ducts on type specimens of *D. quaintaincii*, examined type specimens of *F. multiformis*, hosted a visit by PJG in July 2002 and by MBK in October 2006 to allow study of *Ferrisia* specimens at the USNM, and he collected a number of specimens for this study, including *F. quaintancii* with help from Susan Halbert. Takumasa (Demian) Kondo (previously at UC Davis, California, now at CORPOICA, Palmira, Colombia) trained MBK in DNA lab methods, provided encouragement for this project, collected many *Ferrisia* specimens, especially from Colombia, provided some photos of the live mealybugs and compiled the plate used for Figure 2. Demian Kondo and Peter Cranston (then at UC Davis, California) assisted greatly by taking a trip to Jamaica where they succeeded in collecting *Ferrisia* specimens for us at the type locality of *F. virgata* in Kingston. Cristina Granara de Willink (Instituto Miguel Lillo, Tucumán, Argentina) kindly collected specimens in Argentina. Alex Segarra (Lajas Agricultural experiment Station, University of Puerto Rico) generously collected specimens of *F. pitcairnia* on Puerto Rico and provided biological data. We also are grateful to the following people for arranging loans of museum specimens and sending material: Steve Heydon (Bohart Museum of Entomology, University of California, Davis), Ray Gill

and Gillian Watson (California Department of Food & Agriculture, Sacramento), Greg Hodges and Ian Stocks (Florida Department of Agriculture and Consumer Services, Gainesville, FL), Jon Martin (The Natural History Museum, London) and Danièle Matile-Ferrero (Muséum National d'Histoire Naturelle, Paris). Steve Nakahara (ARS, USDA, Beltsville) provided helpful information on diagnostic taxonomic features of *Ferrisia* mealybugs from his correspondence. Shepherd Myers (BPBM), Luc LeBlanc and Dick Tsuda (University of Hawaii, Manoa) kindly looked for or provided information on Jack Beardsley's collections. Terence Schiefer (Mississippi Entomological Museum) provided invaluable information on Lobdell's types and kindly arranged a loan from MEM. Gevork Arakelian (Los Angeles County Department of Agricultural Commissioner/Weights & Measures) searched the county collection for Lobdell's *Ferrisia* type slides. Greg Evans (PPQ, APHIS, USDA, c/- Systematic Entomology Laboratory, Beltsville, Maryland) kindly checked specimens on a type slide for us. Andrew Richards (Bohart Museum of Entomology, University of California, Davis) assisted with information on type specimens of two species.

We thank the Regents of the University of California and the University of California Press for permission to use a photograph (our Fig. 1) of a painting by Mary Foley Benson used for Plate X of McKenzie (1967), and we also thank the Special Collections of the University of California Library, Davis, for access to and providing a digital copy of the original painting (D309). We acknowledge Stanford University Press for information about G.F. Ferris' figures of *Ferrisia* species, from his "*Atlas of the Scale Insects of North America*", that we have reproduced and modifed for the present publication. We are grateful to Cristina Granara de Willink and Doug Williams for permission to use their illustrations of *Ferrisia* species. We are very grateful to Doug Williams and Demian Kondo for their careful reviews that improved the manuscript and to Chris Hodgson for his editorial comments and corrections.

This research was supported by grant TUBITAK- NATO-B2 that allowed MBK to study in the Gullan and Cranston Systematic Entomology Lab at UC Davis, and by grant DEB-0118718 from the U.S. National Science Foundation (Partnerships for Enhancing Expertise in Taxonomy program) to PJG as well as by Hatch funding to PJG from the California Agricultural Experiment Station.

References

Awadallah, K.T., Ammar, E.D. & Rashad, A. (1979a) Description of immature stages of the white mealybug, *Ferrisia virgata* (Ckll.) (Homoptera: Pseudococcidae). *Zeitschrift für Deutsche Entomologen*, 26, 9–20.

Awadallah, K.T., Ammar, E.D., Tawafik, M.F.S. & Rashad, A. (1979b) Life history of the white mealybug *Ferrisia virgata* (Ckll.) (Homoptera: Pseudococcidae). *Zeitschrift für Deutsche Entomologen*, 26, 101–110.

Ben-Dov, Y. (1994) *A Systematic Catalogue of the Mealybugs of the World (Insecta: Homoptera: Coccoidea: Pseudococcidae and Putoidae) with Data on Geographical Distribution, Host Plants, Biology and Economic Importance.* Intercept Ltd., Andover, United Kingdom. 686 pp.

Ben-Dov, Y. (2005) The malvastrum mealybug *Ferrisia malvastra* (Hemiptera: Coccoidea: Pseudococcidae): distribution, host plants and pest status in Israel. *Phytoparasitica*, 33, 154–156.

Ben-Dov, Y. (2012) ScaleNet, Pseudococcidae. Available from: http://www.sel.barc.usda.gov/scalenet/scalenet.htm (last accessed June 2012)

Cockerell, T.D.A. (1893a) The West Indian species of *Dactylopius*. *The Entomologist*, 26, 177–179.

Cockerell, T.D.A. (1893b) A list of West Indian Coccidae. *Journal of the Institute of Jamaica*, 1, 252–256.

Cockerell, T.D.A. (1896) New species of insects taken on a trip from the Mesilla Valley to the Sacramento Mts., New Mexico. *Journal of the New York Entomological Society*, 4, 201–207.

Cockerell, T.D.A. (1898). The Coccidae of the Sandwich Islands. *The Entomologist*, 31, 239–240.

Cockerell, T.D.A. (1899) Article VII. - First supplement to the check-list of the Coccidae. *Bulletin of the Illinois State Laboratory of Natural History*, 5, 389–398.

Costa Lima, A. (1939) Espécies de *Pseudococcus* observadas do Brasil (Homoptera: Coccoidea-Pseudococcidae). *Boletim Biologico*, 4, 1–10.

Culik, M.P., Martins, D. dos S. & Gullan, P.J. (2006) First records of two mealybug species in Brazil and new potential pests of papaya and coffee. *Journal of Insect Science*, 6 (23), 1–6.

Daane, K.M., Cooper, M.L., Triapitsyn, S.V., Walton, V.M., Yokota, G.Y., Haviland, D.R., Bentley, W.J., Godfrey, K. & Wunderlich, L.R. (2008) Vineyard managers and researchers seek sustainable solutions for mealybugs, a changing pest complex. *California Agriculture*, 62(4), 167–176.

Daane, K.M, Almeida, R.P.P., Bell, V.A., Walker, J.T.S., Botton, M., Fallahzadeh, M., Mani, M., Miano, J.L., Sforza, R., Walton, V.M. & Zaviezo, T. (2012) Biology and management of mealybugs in vineyards. *In:* Bostanian N.J., Charles, V. &

Isaacs, R. (eds). *Arthropod Management in Vineyards: Pests, Approaches, and Future Directions*. Springer, Dordrecht, Heidelberg, New York & London.
Downie, D.A. & Gullan, P.J. (2004) Phylogenetic analysis of mealybugs (Hemiptera: Pseudococcidae) based on DNA sequences from three nuclear genes, and a review of the higher classification. *Systematic Entomology*, 29, 238–259.
Entwhistle, P.F. (1972) *Pests of Cocoa*. Longman Group Ltd. 779 pp.
Entwhistle P.F. & Longworth, J.F. (1963) The relationships between cacao viruses and their vectors: the feeding behaviour of three mealybug (Homoptera: Pseudococcidae) species. *Annals of Applied Biology*, 52, 387–391.
Fernald, M.E. (1903) A catalogue of the Coccidae of the world. *Bulletin of the Hatch Experiment Station of the Massachusetts Agricultural College*, 88, 1–360.
Ferris, G.F. (1919) Observations on some mealy-bugs (Hemiptera; Coccidae). *Journal of Economic Entomology*, 12, 292–299.
Ferris, G.F. (1950) *Atlas of the Scale Insects of North America. (ser. 5) [v. 5]. The Pseudococcidae (Part I)*. Stanford University Press, Palo Alto, California. 278 pp.
Ferris, G.F. (1953) *Atlas of the Scale Insects of North America, v. 6, The Pseudococcidae (Part II)*. Stanford University Press, Palo Alto, California. 506 pp.
Freidberg, A., Susman, I. and Kaplan, F. (1989) *Cotton Insects of Israel*. The Cotton Production & Marketing Board, Israel. 128 pp.
Fullaway, D.T. (1923) Notes on the mealy-bugs of economic importance in Hawaii. *Proceedings of the Hawaiian Entomological Society*, 5, 305–321.
Ghose, S.K. & Paul, P.K. (1972) Observations on the biology of the mealybug, *Ferrisia virgata* (Cockerell) (Pseudococcidae: Hemiptera). *Proceedings of the Zoological Society (Calcutta)*, 25, 39–48.
Granara de Willink, M.C. (1991) Una nueva especie de *Ferrisia* Fullaway en la Republica Argentina (Homoptera: Pseudococcidae). *Insecta Mundi*, 5(3-4), 181–184.
Green, E.E. (1896) Catalogue of Coccidae collected in Ceylon. *Indian Museum Notes*, 4, 2–10.
Green, E.E. (1916) Observations on some recently described Coccidae. *Bulletin of Entomological Research*, 7, 51–52.
Gullan, P.J., Downie, D.A. & Steffan, S.A. (2003) A new pest species of the mealybug genus *Ferrisia* Fullaway (Hemiptera: Pseudococcidae) from the United States. *Annals of the Entomological Society of America*, 96, 723–727.
Gullan, P.J., Kaydan, M.B. & Hardy, N.B. (2010) Molecular phylogeny and species recognition in the mealybug genus *Ferrisia* Fullaway (Hemiptera: Pseudococcidae). *Systematic Entomology*, 35, 329–339.
Gullan, P.J. & Martin, J.H. (2009) Sternorrhyncha (jumping plant-lice, whiteflies, aphids, and scale insects). pp. 957–967. *In*: Resh, V.H. & Cardé, R.T. (eds) *Encyclopedia of Insects*, 2nd edition. Elsevier, San Diego.
Hardy, N.B., Gullan, P.J. & Hodgson, C.J. (2008) A subfamily-level classification of mealybugs (Hemiptera: Pseudococcidae) based on integrated molecular and morphological data. *Systematic Entomology*, 33, 51–71.
Haviland, D., Beede, R., Godfrey, K. & Daane, K. (2006) *Ferrisia gilli*: a new mealybug pest of pistachios and other deciduous crops. University of California, Division of Agriculture and Natural Resources, Publication 8207, 8 pp.
Haviland, D.R., Beede, R.H. & Daane, K. M. (2012) Seasonal phenology of *Ferrisia gilli* (Hemiptera: Pseudococcidae) in commercial pistachios. *Journal of Economic Entomology* (in press).
Hempel, A. (1900). As coccidas Brasileiras. *Revista do Museu Paulista*, São Paulo, 4, 365–537.
Hughes, W.A. & Lister, C.A. (1953) Lime die-back in the Gold Coast, a virus disease of the lime, *Citrus aurantifolia* (Christmann) Swingle. *Journal of Horticultural Science*, 28, 131–140.
ICTVdB Management (2006) 00.015.0.05.003. Cacao swollen shoot virus. *In*: ICTVdB - The Universal Virus Database, version 4. Büchen-Osmond, C. (Ed.). Columbia University, New York, USA.
International Commission on Zoological Nomenclature (1999) *International Code of Zoological Nomenclature*. 4th edition. The International Trust for Zoological Nomenclature, c/- The Natural History Museum, London. 306 pp.
Keuchenius, P.E. (1915) Onderzoekingen en beschouwingen over eenige schadlijke schildluizen van de Koffiekultuur op Java. *Mededeelingen van het Besoekisch Proefstation,* Djember 16, 1–65.
Khalid, M. & Shafee, A.S. (1988). Five new species of Pseudococcidae (Homoptera: Coccoidea) from Manipur, India. *Indian Journal of Systematic Entomology*, 5, 65–73.
King, G.B. (1902) Descripcao de *Dactylopius magnolicida*. Von Ihering. *Revista do Museu Paulista,* São Paulo, 5, 616–617.
Kirkaldy, G.W. (1902) Hemiptera. *Fauna Hawaiiensis*, 3, 93–174.
Kondo, T. (2010) Los insectos escama (Hemiptera: Coccoidea) del mango, *Mangifera indica* L. (Anacardiaceae) en Colombia. Kondo, D.T. Novedades Tecnicas, Revista Regional. Corpoica, Centro de Investigacion Palmira. Año 10/No. 13/ Diciembre/2009. pp. 41–44.
Kondo, T., Ramos-Portilla, A.A. & Vergara-Navarro, E.V. (2008) Updated list of mealybugs and putoids from Colombia (Hemiptera: Pseudococcidae and Putoidae). *Boletín del Museo de Entomologia de la Universidad del Valle*, 9, 29–53.
Liebhold, A.M. & Tobin, P.C. (2008) Population ecology of insect invasions and their management. *Annual Review of Entomology*, 53, 387–408.
Lindinger, L. (1935) Neue Beiträge zur Kenntnis der Schildläuse (Coccidae). *Entomologische Zeitschrift*, 49, 121–123.
Lobdell, G.H. (1930) Twelve new mealybugs from Mississippi (Homoptera: Coccoidea). *Annals of the Entomological Society of America*, 23: 209–236.
Mamet, J.R. (1951) Notes on the Coccoidea of Madagascar - II. *Mémoires de l'Institut Scientifique de Madagascar* (Ser. A), 5, 213–254.

McDaniel, B. (1962) A new species of scale insect from the Rio Grande Valley, Texas (Pseudococcidae, Coccoidea). *Texas Journal of Science*, 14, 323–327.
McKenzie, H.L. (1962) Third taxonomic study of California mealybugs, including additional species from North and South America (Homoptera: Coccoidea: Pseudococcidae). *Hilgardia*, 32, 637–688.
McKenzie, H.L. (1967) *Mealybugs of California with Taxonomy, Biology, and Control of North American Species (Homoptera: Coccoidea: Pseudococcidae)*. University of California Press, Berkeley. 526 pp.
Miller, D.R. & Watson, G.W. (1995) Douglas J. Williams, the modern guru of coccidology. *Israel Journal of Entomology*, 29, 1–4.
Morrison H. & Morrison, E.R. (1966) An annotated list of generic names of the scale insects (Homoptera: Coccoidea). *Miscellaneous Publication United States Department of Agriculture*, 1015, 1–206.
Newstead, R. (1894) Scale insects in Madras. *Indian Museum Notes*, 3, 21–32.
Newstead, R. (1908) On the gum-lac insect of Madagascar, and other coccids affecting the citrus and tobacco in that island. *Quarterly Journal. Institute of Commercial Research in the Tropics*, 3, 3–13.
Nur, U. (1977) Electrophoretic comparison of enzymes of sexual and parthenogenetic mealybugs (Homoptera: Coccoidea: Pseudococcidae). *Bulletin of the Virginia Polytechnic Institute and State University Research Division*, 127, 69–84.
Paul, S.K. & Ghose, S.K. (1989) Descriptions of various instars of *Ferrisia virgata* (Cockerell) (Pseudococcidae, Homoptera). *Environment and Ecology*, 7, 838–845.
Roivainen, O. (1976) Transmission of cocoa viruses by mealy bugs (Homoptera: Pseudococcidae). *Journal of the Scientific Agricultural Society of Finland*, 48, 433–453.
Schiefer, T.L. (2000) Notes on scale insects described by Gladys Hoke Lobdell. *The Scale*, 24, 7–12.
Takahashi, R. (1929) Aphididae and Coccidae of the Pescadores. *Transactions of the Natural History Society of Formosa*, 19, 425–431.
Thorold, C.A. (1975) *Diseases of Cocoa*. Clarendon Press, Oxford. 423 pp.
Thresh, J.M. & Tinsley, T.W. (1959) The viruses of cacao. *Technical Bulletin, West African Cocoa Research Institute,* No. 7, 32 pp.
Tinsley, J.D. (1898) Some new species of Coccidae. *Canadian Entomologist*, 30, 220–224.
Varshney, R.K. (1982) *Ferrisia lobdellae*, a new name for *Ferrisia setosa* (Lobdell, 1930) (Homoptera: Pseudococcidae). *Proceedings of the Entomological Society of Washington*, 84, 857–858.
Vayssière, P. (1912) Deux coccides nouveaux de l'Afrique occidentale [Hem.]. *Bulletin de la Société Entomologique de France*, 17, 366–368.
Williams, D.J. (1985a) *Australian Mealybugs* (Special Publication No. 953). British Museum (Natural Hist.), London. 431 pp.
Williams, D.J. (1985b) A new species of *Ferrisia* (Hemiptera: Pseudococcidae) on cassava (*Manihot esculenta*) from Paraguay and on ragweed (*Ambrosia tenuifolia*) from Argentina. *Bulletin of Entomological Research*, 75, 255–257.
Williams, D.J. (1996) A synoptic account of the mealybug genus *Ferrisia*. *Entomologist's Monthly Magazine*, 132, 1–10.
Williams, D.J. (2004) *Mealybugs of Southern Asia*. The Natural History Museum, London, and Southdene SDN BHD, Kuala Lumpur. 896 pp.
Williams, D.J. & Granara de Willink, M.C. (1992) Mealybugs of Central and South America. CAB International, London, England. 635 pp.
Williams, D.J. & Watson, G.W. (1988) *The Scale Insects of the Tropical South Pacific Region. Pt. 2: The Mealybugs (Pseudococcidae)*. CAB International Institute of Entomology, London. 260 pp.